PRACTICAL
WIRING OF BUILDINGS
FOR
ELECTRICAL APPLIANCES,
BY
E. D. WEBER.

ILLUSTRATED.

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PRACTICAL

WIRING OF BUILDINGS

FOR

INCANDESCENT ELECTRIC LIGHTING,
ELECTRIC GAS LIGHTING,
ELECTRIC BURGLAR ALARMS,
ELECTRIC HOUSE and
HOTEL ANNUNCIATORS,
BELLS, etc., etc.

BY

E. D WEBER,

Practical Electrician and Electrical Contractor.

ILLUSTRATED.

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PREFACE.

THE need of an explicit and trustworthy treatise on the Practical Wiring of Buildings has been felt by almost every one connected with the construction and erection of buildings. In this little work it is the aim of the author to convey to architects, building contractors, mechanics employed in new buildings, apprentices to electric wiremen, and others, such information as will be invaluable to them in the proper and satisfactory performance of electric wiring. A brief description of inferior and unsafe work is also given.

Desirous of protecting from imposition those persons not familiar with the work of electric wiring, the author has prepared this little manual in such manner that any one with but ordinary intelligence can readily understand, and therefore be fully advised.

While he does not claim to know everything about wiring, close study, combined with practical experience of over ten years, has given the compiler the knowledge contained in the following pages. Much inferior work has been remodeled by him, and the suggestions which he makes have all been derived from personal experience.

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Practical Wiring of Buildings.

CHAPTER I.

ELECTRIC WIRING IN NEW BUILDINGS FOR APPLIANCES USING BATTERY CURRENT.

WIRING of new buildings while they are being constructed is, at the present time, very much desired; the work can then be done at the smallest possible expense and in the safest manner. It is, however, desirable and advisable to have it done in the most approved system—and the very best—as all wiring is being improved upon each year. The wiring done six to eight years ago has been very much improved upon by wiremen who are constantly finding and improving past defects. The best is none too good, and still liable to be improved upon.

For all appliances using battery current, such as bells, alarms, annunciators, gas lighting, etc., do not use any insulated wire having a poor light insulation. The lowest grade of insulated wire which should be used is known as "Damp Proof Office Wire." In no case allow to be, or personally use, common annunciator or burglar alarm wire. The insulation on such wire is usually of two layers, wrapped in opposite

directions on the wire, and is of no use in case of dampness, and very many other conditions.

When wiring a new building, one or more set of holes should be made through the floor joists, from front to rear in the building. The easiest way to have these holes made, is, by having a long augur bit, about five-eighth inch size, made about three feet long. This can be had, by getting the ordinary augur bit at the hardware store, and a piece of steel the proper thickness, take them to a blacksmith and have them welded together, with a head on the one end of the steel, to fit into an ordinary brace; should the floor boards not be down, the holes can be made from the top or floor side of the joists. The hole should be started about four inches below the top, and when through the joist, will slant downwards.

The holes should be made in a straight line, as near as possible. Bore a hole in every other floor joist, in the same direction; when the joists are all bored in the one direction, change position and bore the remaining joists in the opposite direction. When the joists are all finished, you will have a set of wave like holes, through which wires can be easily drawn.

When running wires, do not lay a coil of wires down and pull on the end of the wire, letting the wire off of its coil in a spiral manner; have the wire wound off, and keep all the twist out of the wire that is going through a set of holes. It is a little more work at first, but saves time in the end and makes surer work.

Should the floor boards be laid, the holes will have to be made from the ceiling side of the floor joists, a step ladder or scaffold from the floor will be necessary, and all holes can then be made about three inches from the ceiling side of the floor joists. They should always be made so no nails from the floor boards, or from the lath, can possibly reach to where the wires are. In a building where many appliances are to be used, a separate set of holes for each appliance is desirable, namely: one set of holes for the bell and annunciator work, one set for the burglar alarm work, one set for the gas lighting work, etc. Never place all the wires into one large hole, as it is not always safe to do so. In ordinary buildings, such as are built in small cities and towns, one set of holes in the floor joists of the second floor are all that are necessary. All wires from the first floor can be easily run from the bell button, or other outlet up to the holes, and all second floor work brought down to them.

Never allow wires from any floor to hang in the cellar, contemplating to finish the work when the building is completed, neither run a number of wires on the ceiling of the cellar.

Where the holes come in contact with any pipes, such as gas, water, steam, or with any heat conductors of metal, of any kind, keep the wires as far away from such places as possible. Never let any wires lie against such places; where possible keep all wires above the pipes. Where wires go below the pipes

place a piece of sheet lead below the pipe in such a manner that no moisture can get to the wires. Keep wires clear from all pipe work, and treat the wires as far as insulation goes, the same as you would treat a non-insulated or bare copper wire, when working around metal work.

Where wires are laid between the floor joists and run in the same direction, they should rest upon pieces of wood, placed at short distances from each other, so that the wires do not hang without sufficient support. For this purpose small pieces of wood with holes or grooves in them, to allow the wires to pass freely, are the best to use. Never fasten wires with nails or double pointed tacks.

When wires run within a partition, keep them out of harm's way, by placing them, as near as possible, in the center; make sufficient fastenings or blocks to prevent the wires from hanging loose, and thus coming in the way of other workmen, namely: plasterers, carpenters, etc. By closely observing these rules, no trouble will ever occur from broken or cut wires.

Where wires go upward through the partitions or side walls to the floor above the most caution must be used at the top of the floor for a distance of about four inches.

When plastering is being done, very much of the mortar used falls down on the inside or behind the lathing; this mortar is often from two to four inches thick, and where wires go through such places, they

should be protected for about six inches above the floor, with either hard rubber tube, electric light wire conduit, or a box of wood, so made, that the wires will pass through and be protected from contact with the mortar. This is an important matter in all wiring, where the insulation of wire used can be affected by the action of the lime or cement of the plaster or mortar.

In all solid walls, where the plastering comes on the brick or stone, never allow any wires to be plastered over. In such places use electric light conduit. Cut out the wall so that the conduit will not show through the plastering, and have it run all in one piece, from the outlet down under the floor. When the plastering is done, run the wires into the conduit, and no trouble will ever occur to them.

CHAPTER II.

WIRING IN OLD OR OCCUPIED BUILDINGS.

While there is much inferior work done in new buildings, into which Electrical Appliances using battery current, such as bells, alarms, annunciators, gas lighting, etc., are introduced in course of erection, the work done in old or occupied buildings is much oftener done poorly than good.

In a new building a good deal can be seen while being done; but in old buildings the wires are gener-

ally concealed at once, and no person except the one doing the work knows how the work has been done.

Many of the mechanics, doing wire work, do it by contract. When the contract is made, they do it as quickly as possible, using cheap material, and very often do not examine under floors, etc., to get the work done in the best possible manner. Their object is to make as much money out of the work as possible, and get it as soon as possible. Many of the self-styled electricians of to-day are young men who work for a few months with some Electric Light Company, some contractor, or go into the business because they know enough to put up an electric bell so it will ring. They have very limited ideas and experience and very often do not know what a piece of work is actually worth.

They guess at the amount and get the work. Should it be done by them at either a high or low figure, it is never satisfactory. After they are once paid for the work, they never come back when sent for to make repairs, and generally, when some other mechanic comes to repair it, he finds it in such a condition that the only thing to be done is to have the work done a second time.

To wire an occupied or old building, some practical knowledge of the construction is necessary to the person who is to do the practical part of the work. To know how the floor joists are placed, how the building and bracing of partitions is made, etc., is of very great advantage to the practical wireman or electrician. The

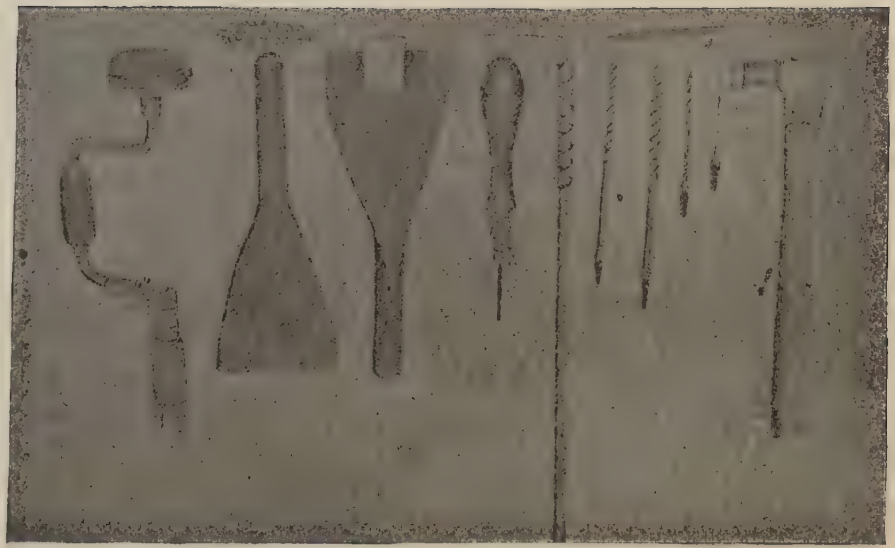
work of wiring occupied or old buildings properly must never be entrusted to any one who does not possess a good knowledge of the way in which it should be done.

The only parts in the building which will be disturbed are the carpets (when they are down) and the floor. The best time to have the work done is just before house-cleaning time; the rooms can then be cleaned after the work is finished, and very little trouble or inconvenience will be experienced.

In buildings having hall-ways most of the work in them can be done very easily. In buildings having no hall-ways a straight line from the front to the rear should be planned.

After the carpet is removed you are ready to take up floors. Never allow wires to be run on top of the floors, to be covered by the carpets.

To take up a floor-board properly several tools are needed, namely, two floor chisels, key-hole or compass saw, several small bits, a ratchet brace, a good heavy hammer, and a good cross-cut saw. These tools, except the floor chisels, can be procured at any hardware store. The floor chisels are easily made by getting two pieces of octagon or round steel at the hardware store, 12 to 14 inches long, and having them drawn out by a good blacksmith so they will be tapered thin and about three or four inches wide at the one end. Do not have them too blunt—make a good thin, knife-like point or end on them.



FLOOR TOOLS.

In taking up a floor board, begin at the end of the board; in case the board has no ends, or the ends are at such places not to be easily reached, bore a hole and saw the board off with the compass saw; find the grooved side of the board (all floor boards of late years have a tongue on one side and a groove on the other) by carefully holding the floor chisel in a slanting position; the floor chisel can then be driven between the two boards, so that the board to be taken up will have a small piece of its lower or under side cut off, which fits over the tongue of the board next to it. The tongue of the board next to the one to be taken up and the floor side of the same, need not be injured at all, after the board is started; by using the two floor chisels it can be raised its entire length on one side; then the nails holding it on the tongued side can be cut off and the board taken up. Should the board be nailed from the top, so the nail heads can be seen, they may be drawn out with a nail-puller, or they may be driven through the floor board into the joist by using a nail punch. It is, however, best to draw the nails, where it is possible to do so.

When one or more boards are taken up, they should at once be fitted together, into their former place, and left there that no openings will be exposed, except where wiring is being done. When boards are left up very often accidents occur, by persons not being careful, stepping into the opening, and breaking a hole through the ceiling below. The boards should never

be nailed or fastened until the work is completed and tested.

When taking up floor boards, take them all up for a straight line, as near as possible, from front to rear of the buildings. The straight line is the easiest part of the work, in old buildings. To get wires in the same direction as the floor joists are, is easily and quickly done, by the use of a fishing steel, or a stiff piece of brass, or steel wire. The fishing steel is made for this kind of work, and is the best article to use.

Examine under the floors, for iron pipes, and bracing, as these are generally the only obstructions met with, when placing any wires under floors, in the same direction as floor joists go. To get from under a floor upwards with wires, is done by removing a small piece of floor board close to the base board, then by reaching below the floor, a hole can be made up through the floor, and behind the plastering. For bell wires, etc., these holes can be mode of a sufficient size to allow of a number of wires to go through one hole. At some places, a sill is placed on the floor joist, and the studdings for partitions are on the sill; where this is found the sill has to be cut out enough to let the wires pass by, or through it. On the top of the partitions often cap pieces are found; these can be easily got through by going to the floor above, locating the place, and taking up a small piece of floor board. The cap piece is then easily cut or bored for one or more holes. When wires are to be placed from the top of a

partition or wall, having space behind the plastering, the work can easily be done by using a piece of chain and some strong thread or twine.

For a bell or button on a wall, make a small opening directly under the place where the bell or button is to be placed; tie the chain on the thread, and force the chain through the hole; the weight of the chain will pull the thread in, and the chain and thread will fall down to the bracing or to the floor. If the chain falls to the floor, it can be easily reached through an opening through the floor, and into the partition; then with a small piece of fishing steel or wire having a hook on its end, the chain and thread can be soon secured. When the thread is secured, use it to work a good strong piece of twine through the opening in which the thread was before trying to pull the wires through; tying the wires to the thread is not safe, as the thread is not strong enough and will easily break; twine is safer, and not so much care is necessary on account of breaking. All holes made into walls should be so made that the instrument they are intended for will cover and hide the hole made. Should the bracing be discovered, it must be sounded and located; in case the bracing is straight, or on a level from side to side, the safest way is to have a long augur made, and a hole bored through it from above downward. Should the bracing be high on one side and slant downwards, it can be easily removed by the use of a piece of pipe and a heavy hammer. Get the iron pipe

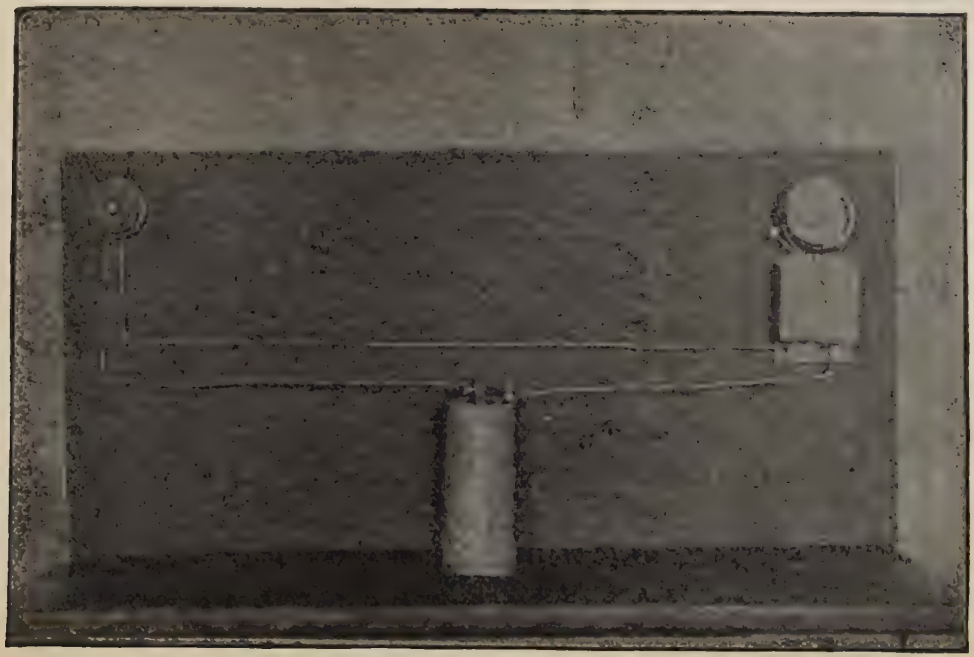
to the lower side of the bracing, by hitting on the pipe; it will soon loosen the bracing. This style of bracing is usually held in place by two nails on each side; the lower side of the bracing is the only place to loosen it, when working from above. In solid walls no wiring can be concealed, unless the walls are cut out, and after placing a conduit or raceway for the wire they must again be plastered. This can be neatly done on walls that are about to be re-papered, or re-finished; never place wires in plaster or mortar, and cover them with it. No wires should be fastened in such a manner anywhere; all wires should be loose and free when the work is finished.

CHAPTER III.

WIRING FOR AND CONNECTING ELECTRIC BELLS.

An Electric Bell outfit usually consists of one electric bell, one cell of battery, one push-button, and wire enough to connect the outfit for a reasonable distance.

The push-button is set at the place from which the signal is to be given, and when connected the pressing of the button should ring the bell. The bell should continue ringing as long as the button is pressed. In single stroke bells, the bell is tapped but once for every time the button is pressed. The bell is placed where the person who is expected to answer it [when



ONE ELECTRIC BELL CONNECTED TO ONE BUTTON.

it rings] is, or near, so it can be heard by them. The battery, the motive power, is placed at some convenient place, the closer the battery is placed to the push-button, the better for some work.

The wire is used to make the connection to the bell, battery and push-button. The proper way to connect an electric bell outfit is, to run one wire from the push-button to the battery, one wire from the push button to the bell, and one wire from the bell to the battery. This gives two wire ends at each place, namely, bell, battery and push-button. The bell, battery and push-button each have two places where the wires are connected. To all places to which wires are connected, the insulation covering of the wires must be removed, and the wire made clean and bright. Then connect it with the connecting places of the push-button, bell and battery. This way of connecting an electric bell outfit is called a metallic circuit.

On long distances wire can be saved by using a grounded circuit, which is done as follows: Drive a piece of iron into the earth, from four to five feet down; connect a wire to the iron driven into the ground by wrapping the bare wire tightly around the iron. This ground wire is then run to the battery and connected to the zinc side. A second wire is run from the carbon side of the battery to one side of the push-button; a second wire runs from the push-button to wherever the bell is placed; a wire is run from the bell to a second ground iron, and attached or connected to the

ground iron, the same as the first ground connection was made. Where long distances are to be connected, namely, from house to stable, factory or any other building, this way of doing electric bell work is frequently done. All wires that are outside of buildings should be fastened onto porcelain or glass insulators, and never be nailed against brick or stone walls, or any frame buildings; always use insulators and have wires clear of all places.

For electric bell work use no lighter wire than No. 16, and use a wire having a good insulation or covering.

For outside work iron wire may be used, but should never be lighter than No. 14. A light iron wire is easily broken, and is a poor conductor for a long distance, unless plenty of batteries are to be used.

In all ordinary electric bell work, if reasonable care is taken, no connections or splices are necessary in the wire. Should it be necessary to make a connection of two ends of wire, make a good one and solder it; do not neglect doing this (soldering connections) in case you cannot solder the connections, wrap them with tin foil, or some tissue paper, and on top of this use some insulating tape, making a good covering over the wire again. Do not, however, use insulating tape right on a wire connection, as the place gets corroded, and is an injury to good work.

When it is desired electric bell work can be so arranged so one, two or more bells can be rung from

one or as many more places as desired. This is all simple work and can be easily understood by looking at the electric bell circuit diagrams.

The wire for push-buttons must be always connected in multiple, with the wire attached to the first push-button. This is easily done by making half connections. The push-button end of wires must always be so connected in open circuit bell work.

The bells when so connected that two or more ring simultaneously, should be also connected in multiple.

BELLS IN MULTIPLE.

By connecting in this way the best results are obtained. When bells are connected in series, one bell getting out of adjustment the whole system is defective. By connecting bells in multiple when one bell gets out of order it does not affect the rest of the bells on the circuit.

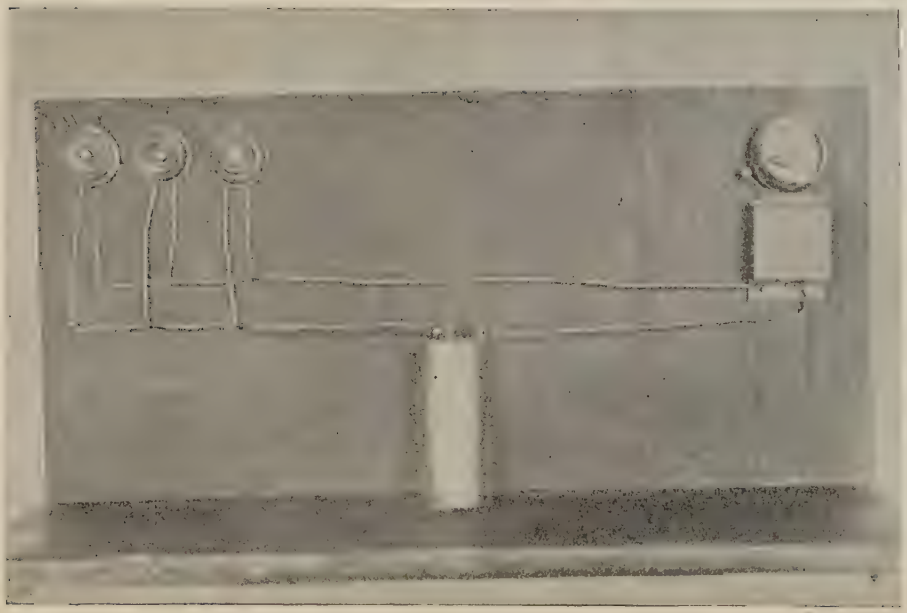
Two bells connected in series, using one cell of battery, hardly ever give satisfaction.

Two bells connected in multiple, always are satisfactory.

Three bells connected in series, using one cell of battery, never give satisfaction.

Three bells connected in multiple, will ring fairly well. By using two cells of battery, they will ring good enough to satisfy any one. Try it and be convinced.

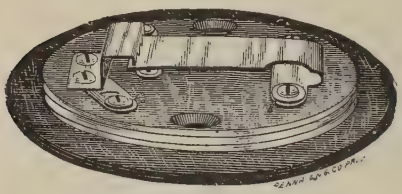
There need be no fear of electric bells not giving



ONE OR MORE PUSH-BUTTONS TO RING ONE BELL.

perfect satisfaction if they are properly put up. Use good material and do the work right. Do not fasten any wires with double pointed tacks or any nails directly on the wire. Follow general rules regarding wiring, and the work will then be sure to give the desired satisfaction.

Electric bells on a return call system, namely, to send and receive signals, are very often desirable, and can be constructed on a one, two, or three wire system. On long distances, between signaling places, the one wire system is generally used; on a system where much signaling is desired, a two wire system is best. On short systems the three wire system is preferable.



THREE WIRE PUSH-BUTTON.

On a one wire system special push-buttons are used, having three contact points and three places for connecting wires, namely, a long spring, a closed circuit spring, and a battery spring. The push-button is termed an open and closed circuit button; two sets of battery are required and the line is run as follows:

We will term the stations as No. 1 and No. 2. At each station a ground iron is driven; from this ground iron at No. 1 we connect a wire to the zinc side of a battery at No. 1 station. From the carbon side of the

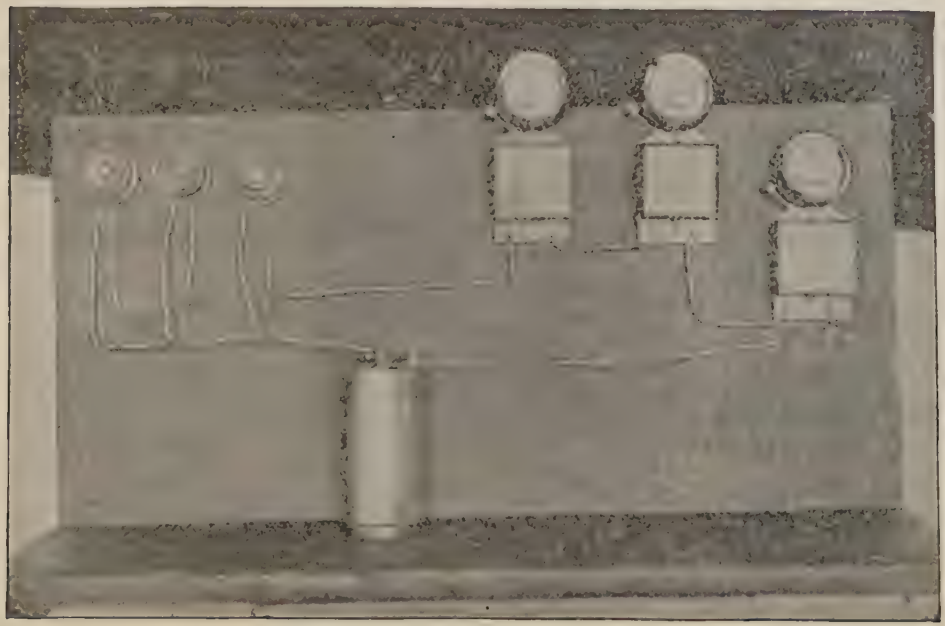
ONE OR MORE PUSH-BUTTONS TO RING ONE OR MORE BELLS.

battery we go to the push-button at No. 1 and connect with the battery or open circuit spring. This is the under or bottom spring in the button. We again connect a second wire to the ground wire at No. 1 ground and run this wire to the bell at No. 1 station. From the bell a second wire is run to the short or closed spring in the push-button; this is the upper or top spring in the button. A third wire is then run from the long or third spring of the button. (This spring is always against the top or short spring, except when the button is pressed to ring the bell at the opposite station). The wire from the long or third spring at No. 1 button goes to the long or same spring at the push-button at No. 2 station. This is the one line wire.

At No. 2 station connections to ground and battery are made as at No. 1 station. When this is done the system is completed. On this one wire system both bells cannot be rung at the same time. Should both buttons be pressed at the same time neither of the bells will ring.

On the second or two wire system this difficulty is overcome, and both bells can be rang at the same time, by one person at each button, pressing the button at the same time.

This is connected as follows: Stations No. 1 and No. 2 both have ground irons or ground connections. From No. 1 ground iron run the wire to the zinc side of a battery at No. 1 station. From the carbon side of the battery run one wire to the push-button at No. 1 sta-



ELECTRIC BELLS CONNECTED IN SERIES.

tion. From the push-button run a second wire to the bell at No. 2 station. From bell at No. 2 station, run a wire to the ground connection of No. 2 station (all wires from bell to ground connection must never be connected through the battery, but to the ground wire, leading from the zinc side of the battery, or to the ground connection. At No. 2 station the same work and connections as at No. 1 station must be made, and the line wire from No. 2 station push-button must come to the bell at No. 1 station, making the two wire return call system.

This system is desirable where much signaling is done in rapid succession. It is, however, not much used. The material needed is two ordinary push-buttons, two bells, two sets of batteries, two ground irons and wire.

On a return call system of two bells and push-buttons, in a residence or office, to be connected to signal both ways, this method of wiring is very much used. Use three colors of insulated wire and you will have no trouble in the connecting places. Only one set of batteries are necessary, and both bells can be rung at the same time. I will suppose we have wires whose colors are black, red, and blue.

From the carbon side of the battery we will run the red wire to one side of the push-button at No. 1 station, a second wire from the push-button at No. 1 station using the black wire, is run to one side of the bell to be rung at No. 2 station. From the bell at No. 2

station, a second wire of blue is run to the battery, and connected to the zinc side of the battery. This is now one bell circuit completed. The only thing to be done now is to be careful and follow directions. Connect a wire to the blue wire at No. 2 station bell, and run it to one side of the No. 2 station push-button (this is the blue wire from the No. 2 station push-button), run a second wire, black, to the bell at No. 1 station; from the bell at No. 1 station, run a second wire—a red wire—and connect it to the red wire at No. 1 station push-button. This completes the work, only one set of buttons are used and both bells will ring, should the both push-buttons be pressed at the same time.

This matter can be better understood by using a piece of paper, making marks for bells, batteries and push-buttons; as you read along, remember what you are reading; draw lines from place to place as read, by repeating this experiment a few times, you will understand what is desired to be explained, and you can use your own diagrams to work from. Try it.

CHAPTER IV.

ELECTRIC WIRING IN OLD OR OCCUPIED BUILDINGS FOR ELECTRIC BELLS.

In wiring an Old building we will begin with the work of putting up electric door bells.

Locate the height of the push-button, at the front door; have an augur bit long enough to get a hole

through the door frame. In case the wall inside of the door-frame is hollow, which can be easily discovered by sounding the walls with the hand, or a hammer. If the wall is hollow, or if there is any space back of the lath and plaster, commence boring the hole where the push-button is to be placed; hold the bit so that it will bore slightly upwards, and to the side away from the face and side of the door frame. For instance, if the door frame is 8 inches deep, the hole must be made so that it will go from 6 to 8 inches out of a straight line away from the door frame, on the inside.

Now, by having a small piece of iron wire, about No. 14, a small piece of brass or iron chain, small enough to easily go through the hole made, and about a foot or less long, a good strong piece of cord or line, not too heavy, or a piece of strong linen thread, proceed as follows:

Tie the chain to the thread or cord; make a small hook end, on the one end of the No. 14 iron wire; with this hook work the chain through the hole, and when it is through, work enough thread or cord into the hole, so that the chain will fall to the floor. The chain can easily be located by pulling and dropping the chord or thread; should the chain and string hang on the inside of the plastering, by a little patience and pounding with the hand against the wall, the chain will soon fall to the floor.

Now go to the cellar. With the brace and bit make

a hole up through the floor, back of the lath and plastering, just where the chain was; when the hole is made the No. 14 wire can be used and the chain, etc., can soon be fished down. Should the thread and cord not be good and strong, fasten a good strong cord or twine to the thread or cord, and pull it up to where the push-button will be. With this piece of strong cord the two wires may now be drawn up from the cellar to the push-button. Run one of the wires from the push-button to the battery and the other wire from the push-button to the bell; from the battery take a second wire to the bell, keep the wires in this case along the ceiling of the cellar, to wherever they may go up to the bell. If the wall is hollow (which is generally the case) at the place where the bell is to be put, make a hole (just under the place for the bell) through the wall about one-half inch in diameter, drop the chain or string down the partition and it will fall to the bracing or to the floor.

Now go into the cellar, locate the place where the chain lies, make a hole up through the floor, be careful that the hole comes inside of the space back of the lath and plaster. The chain and string can now be easily secured and the wire drawn up to where the bell is to be located. Should bracing be in the way, it can be sounded, and should the bracing be on a level from side to side, or from stud to stud, it will generally have to be bored (with a long bit) from the cellar up. Should the bracing be higher on one side and be

fastened so the bracing is not even, it can be removed by using an iron rod, or a piece of gas pipe through the hole in the floor. Run this iron pipe up against the highest side of the bracing, by using a heavy hammer, and driving the iron or pipe up against the bracing, it will then soon get loose and move, so that the chain and cord, or thread, can fall to the floor. All bracing is usually nailed with two nails on each side; when driving bracing from below, the high side should always be driven. When driving bracing from the top or upper side, the lowest place should be found before trying to remove the bracing. The bracing is only a slight obstacle and no good mechanic will have any difficulty in removing it.

The wires in the cellar can now be finished. The way to fasten wires in cellars is by using small wood cleats; nail or screw them against the ceiling of the cellar and keep the wires about three inches apart when fastening them. Electric door bells, when put up in this manner, never fail to give satisfaction. Make all connections at connecting places, that is, battery (2), bell (2), and push-button (2), good and tight. Examine the push-button, and try to have one-eighth of an inch clear space, between the springs of the push-button when button is connected and the work is finished. Also examine the bell and see that all binding and connecting screws are tight; in wood box bells the screws are very likely to be somewhat loose; they should be thoroughly tightened before the bell is fastened to the wall.

Trouble will be very rare when work is properly done, and can easily be ascertained should any occur.

Where wires cannot be concealed around door frames or other places, they should have a wood covering (molding) over them. The molding can be so made that it will not be unsightly, and when woodwork is painted the molding can be painted the same color. This molding can be made with a groove large enough to allow the wires to be placed inside; the molding should be carefully fastened so no nails come in contact with the wires. Never use double pointed tacks to fasten wires, if you want good work done.

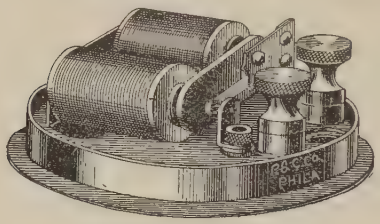
CHAPTER V.

ELECTRIC SIGNALS.

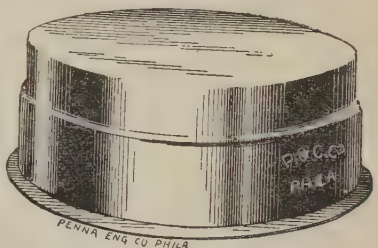
Electric signals, consisting of a bell which will ring when a door is opened, or when a person enters through a door, are frequently desirable. They are often operated by means of a door-mat so placed at the entrance that when a person steps upon the mat a signal is given by the bell.

The work of putting up these signal bells is done in a similar manner as wiring for an electric door-bell. In place of a push-button, two wires are connected to an electric door mat, a door-spring or door-trip, which close the circuit where either is in use. When the door is left open a floor-mat, made for the purpose, is used. This

mat has a number of springs, and can be had of any suitable size. It is placed under a piece of floor oil cloth, and is never noticed. Signals of this kind are in demand in small stores and business places, where the entrance cannot at all times be watched. The opening of the door, or the walking over the floor-mat causes the bell or buzzer to ring, and thus calls the attention of the clerk, or some one supposed to attend. All work of this kind should have a switch connected in the circuit, so that the bell can be turned off, or stopped from ringing, when the signal is not desired in use. The cutting out of the bell saves the battery and the cost of the switch is saved in a short time. Switches in such cases should be arranged for at a convenient place. For office signals, a buzzer is often used in place of a bell. Bells are too loud for some places, and are not always suitable or necessary. A buzzer makes a noise similar to the humming of a bee, and is very much used for silent calls,



BUZZER UNCOVERED.



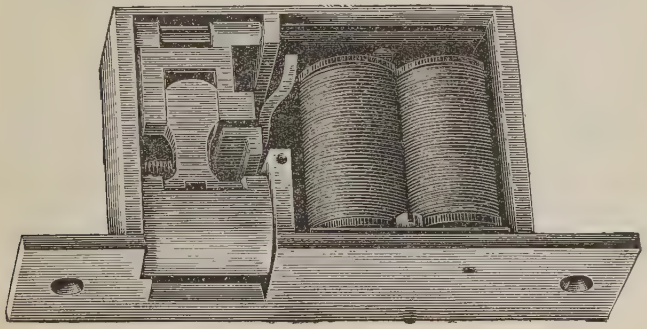
BUZZER COVERED.

and for signals from dining rooms, in private residences. The push-button being placed under or on the dining table, and the buzzer in the kitchen, or pantry, where the person who attends to the dining room work is supposed to be. These signals are all wired the same as ordinary electric bells.

CHAPTER VI.

ELECTRIC DOOR OPENERS.

Electric Door Openers are wired in the same manner as electric bells are. The door openers have the same ends of the wiring as a bell. They are placed

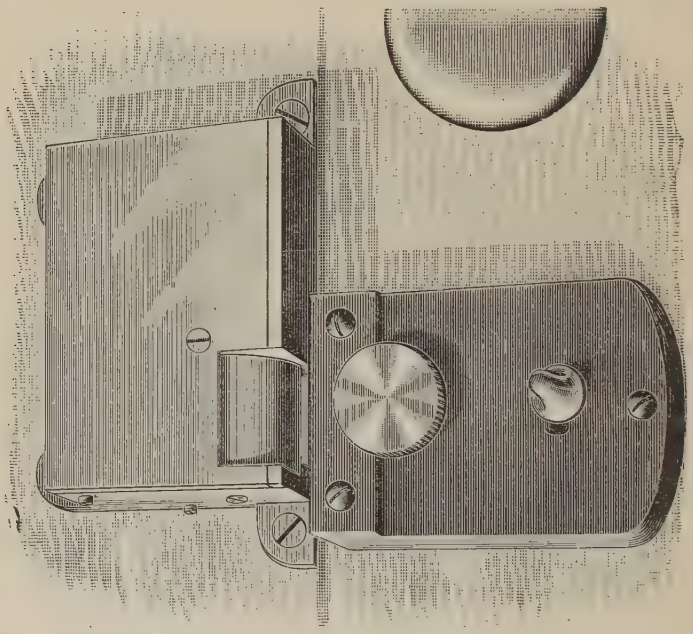


ELECTRIC DOOR OPENER—MORTISE PATTERN.

in the door frame, on the same side on which the lock is, and opposite the door lock. It is so placed that the bolt of the lock is held fast in the door opener. By pressing a button, the door opener releases the lock on the door that is to be opened. This opener always

resets automatically, and the button is used only to unlock the door.

Door openers usually have two electro-magnets; the wire from the binding or connecting screws go



ELECTRIC DOOR OPENER—RIM LOCK PATTERN.

from the first connecting screw to the electro-magnet, from the first to the second electro-magnet, from the second electro-magnet, to the second connecting screw; when a button is pressed, which is connected in the circuit of a door opener, the circuit is completed

and the electric current flows around the electro-magnets, magnetizing the core of the two electro-magnets; opposite these two cores, one in each magnet, an armature is placed, arranged so that a slight movement of the armature towards the electro-magnets, releases a small mechanical catch, and the door opener is unlocked; the electric current flowing around the two electro-magnets magnetizing their cores, draws the armature over against the electro-magnet, and by so doing, releases the catch of the door opener. The instant the circuit is open, by releasing the pressure on the push-button, the electro-magnets lose their magnetism, and the armature having a small spring attached to it, moves away from the magnets. This causes the catch of the door opener to again become fastened, and the door is again locked.

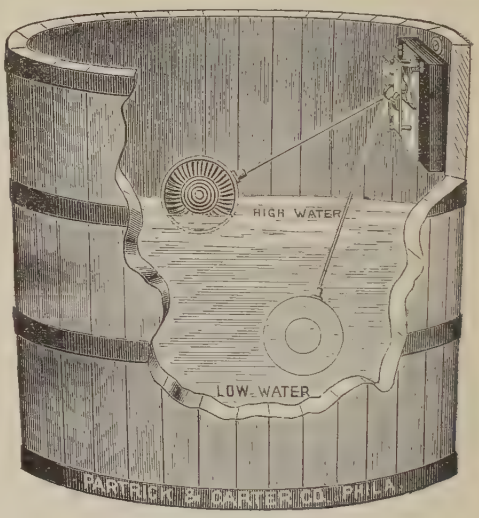
The mechanical construction of a door opener is very simple, and can be easily understood by the average person. A door opener can be controlled from any number of places, by the use of push-buttons connected in multiple to the wires, the same as two or more push-buttons to one electric bell. (See illustration of two or more push-buttons to ring one bell.)

CHAPTER VII.

WATER TANK ELECTRIC ALARMS.

Water Tank Electric Alarms are used for the purpose of ascertaining the state of water in a tank when they are either nearly empty or overflowing. Tanks

may be located in buildings or away from them. By means of floats arranged on the inside of the tank the alarm can be so regulated that it will indicate whether the tank is nearly full of water or nearly empty. When the water in the tank is about to overflow or the tank becomes empty, it will ring the alarm signal.



ONE STYLE WATER TANK ALARM.

To wire for a tank alarm so that the water can neither overflow, or the tank become empty, three wires are run. The one wire from the carbon side of the battery is run to two connecting places at or in the tank; one wire from the zinc side of the battery is run to two bells; have the two bells so their sound is not alike when ringing. Mark one bell, high water, one low water. A good loud bell for low water, and a weaker bell for high water, is a good plan to follow. From the high water bell run the second or line wire to a switch;

through the switch to the high water connections at or in the tank; from the low water bell also run a wire to a switch, and to its low water connection at or in the tank; the tank connections are made like connections on a push-button. Two springs are so made that a weight can close the circuit whenever it comes against the springs or push-buttons. The weight can be arranged either by the use of a wooden float on the water in the tank, or by a hollow ball which will float on the water; from either of these floats rods or chains can be used, and a mechanical arrangement provided, which will close the contact points at the high or low water connections, and cause the bell to ring. The switches in the circuit are intended to throw off when the bell rings. By doing this the battery or motive power is saved, and the annoyance of the continuous ringing of the bell is avoided. Where more than one tank is desired to be connected, an annunciator can be used and so connected, that each tank will alarm and indicate. They are then easily attended to.

CHAPTER VIII.

HOW ELECTRIC BELLS SHOULD NOT BE PUT IN.

Very often electric bells are put in buildings by using a grade of cheaply insulated wire, known as annunciator or burglar alarm wire. This kind of wire should not be used. The wire has a cotton insulation

of two layers—the second one is wrapped on the wire in an opposite direction from the first. This method of insulation is easily injured, and does not insulate against dampness. When iron comes in contact with such wire it will soon show a drain on the battery; then trouble begins. Double pointed tacks should never be used. They cause as much trouble with batteries as cheap insulation on wire does. Avoid using cheap insulated wire and double pointed tacks. When such wire is run and each wire is kept under separate tacks (no two wires under one tack) the trouble does not soon occur; but in time the tacks will cause the wire to break at the places where they have been driven tight; also where dampness exists, the tacks will rust, and the rust will eat the insulation from the wire. When tacks and wire are subject to dampness, the wire will corrode and break at such places where tacks come in contact with it.

Where two wires are placed under one double pointed tack, trouble becomes so frequent that the work can never be depended upon. On door bell work done in this manner, the bell will sometimes ring when the button is pressed; very often will not ring. Again, the bell will ring when no one is around and keep on ringing, until either the battery is exhausted, or one of the wires is disconnected at the battery, or bell. Sometimes the wiring is in such a condition, that every few months a new battery is necessary, this is always the result of poor work.

Where two wires are under one tack, and the two wires are the ones from the battery, if the tack is driven tight, it soon causes a partial short circuit, and the battery is having a steady drain; in this case the bell will ring for a short time and then stop. Where the tack is driven so that it makes a good contact, the battery is on a closed circuit and soon becomes worn out. The work will not be satisfactory until the tacks are removed. Should a tack be driven over the two wires coming from the push-button towards the bell and make a partial contact, it will be a drain on the battery, and the bell cannot be depended on when push-button is pressed. Should the tack at any time make a good contact, the bell will ring when no one is around; this is a common occurrence where common annunciator wire is used, fastened with double pointed tacks, having two wires under one tack. Should the two wires coming from the bell be under one tack, the tack will so affect the bell that it may or may not ring. In case the tack makes a good contact the bell will never ring, as the current will flow through the tack and none go through the bell.

Double pointed tacks should never be used on any electric wiring.

At very many places wires are run from the front door push-button down the door casing to the base board (or sometimes up the door casing to the picture molding and over ceilings, etc., to bell). When run down to base boards, and along base boards around

door frames, and in almost any manner so that the push-button, battery and bell get connected, using double pointed tacks to hold the wires in place, and the wires run regardless of appearance, the work will not remain satisfactory for any length of time. Any person who does work in this manner, should not be allowed to do electric bell or any other kind of electrical wiring. He does not have any idea of doing the work properly. When such work is done, no pay should be given for it.

Have your work done well and with good materials; you will avoid much annoyance and inconvenience after the work is completed. Most any kind of wiring will do for a few weeks, but sooner or later, trouble will come, unless the work is properly done.

CHAPTER IX.

REPAIRING ELECTRIC BELL TROUBLES.

On electric bell work, when properly done, there are only three places where trouble can occur, namely, at the battery, bell and push-button.

When the bell refuses to ring, first examine the battery. Either a loose connection or a dry battery, made so by the evaporation of the water, or a zinc eaten in two, can cause the trouble. Take the battery down in case it has been in use for a long time—two or three years or more; thoroughly clean it, throw away the

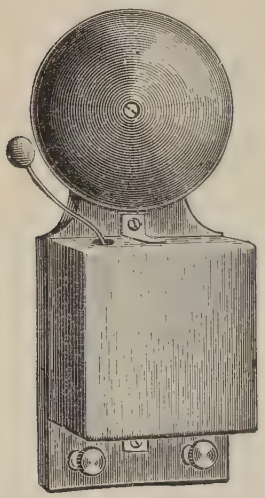
old solution, make a new one. Should the zinc be well eaten or used get a new zinc; have the solution of the battery to fill the glass jar to within two inches of the top; then replace and connect the battery. Where a number of bells are operated from one set of batteries, the battery trouble need not be looked for except when none of the bells ring.

Bell trouble can be found at the binding posts or screws, where the wires are fastened to the bell. On wood box bells, the wood dries out, so the binding posts become loose. These posts being loose, the wires on the back of the bell—one leading from one binding post to the magnets; the other from the second binding post to the frame of the bell—can cause trouble to the bell. When wires are found loose the bell can sometimes ring; as a general rule it never rings.

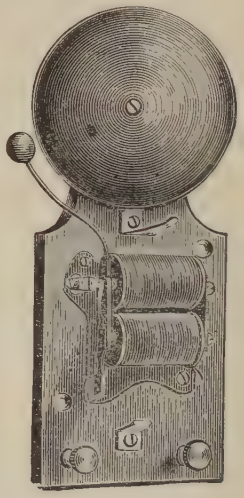
These binding posts must be tight. Sometimes trouble will be found in the adjusting contact points; a little dust or dirt getting directly under the point of the adjusting screw, can cause trouble.

Electric Vibrating Bells usually have two electro-magnets. The electro-magnets somewhat resemble spools of thread, the wiring of a bell can be easily traced, namely: from one binding post of the bell to one of the electro-magnets or spools; from the first to the second electro-magnet; from the second electro-magnet to the insulated support of the adjusting screw; there one wire appears to end. The wire from the

second binding screw usually connects with the frame of the bell. Should the box of the bell be wood, then the wire from the second binding screw of the bell will lead to the armature or iron frame of the bell; the armature is made of iron, has a spring fasten-



ELECTRIC BELL covered.

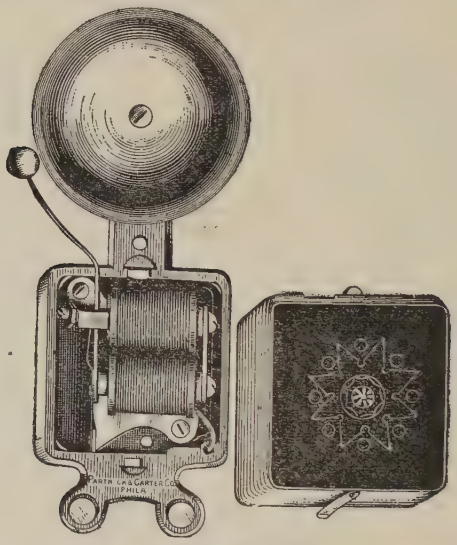


ELECTRIC BELL cover removed.

ing, either riveted or screwed to the frame of the bell; this armature has a small spring on its side or front opposite the side which is towards the electro-magnets; this small spring makes a contact with the adjusting screw, having the end of the wire from the second magnet. The armature has a spring movement and always is away from the two electro-magnets; the small armature spring resting against the contact

point of the adjusting screw. When a battery is connected to the bell, on a closed circuit either direct or through a push-button, the current of electricity flowing through the wires, and around the electro-magnets, cause the cores of the magnets to become magnetized; the cores being magnetized, the armature is drawn tight over against the magnets; when the armature is so attracted the small armature spring, having had a contact with the adjusting screw of the bell, now loses its contact if properly adjusted. [This contact being broken, the electric circuit is opened the same as if the wire were parted.] The circuit being broken, the electro-magnets lose their magnetism, the armature which had been attracted to the magnets now springs back to its natural position; by springing back, the armature again completes the electric circuit through its armature spring, making connection with the adjusting screw of the bell. This making and breaking of the electric circuit is so rapid, as long as the circuit remains closed at all other places, that a continual ringing of the bell is the result. By watching closely at the contact points of the armature spring and the adjusting screw, a small spark of fire will be seen every time the armature is drawn over to the electro-magnets. At this adjusting screw trouble can occur as follows, namely: should the adjusting screw remain in contact with the armature spring, when the armature is drawn over against the magnets, the circuit is closed, and the bell may

or may not give one tap; depending on how far the armature is away from the magnets; the battery is, however, short circuited and is working. Should the contact spring of the armature not make contact with



AN IRON BOX BELL.

the adjusting screw of the bell, the electric circuit is not complete; when button is pressed no ringing of the bell can be then had; by connecting a bell to a battery, and using a screw-driver at the adjusting screw, the intentions of the adjusting screw and armature can be soon understood. Should the wire to the adjusting screw support become bare, and come against the iron frame of the bell, the bell will strike

but once every time the circuit becomes closed; should the insulation at the adjusting screw support become defective, the same result will be had; the adjusting screw must in all vibrating bells be perfectly insulated from the frame of the bell.

Sometimes the insulation at the binding screw of the bell, where the wire from one of the electro-magnets is connected becomes defective, or the wire from the magnet is not insulated, and the bare wire makes contact with the frame of the bell, the bell will then not ring, as the electric current goes through the frame of the bell, and does not flow through the wire of the electro-magnets. When such is the case the bell does not ring until the wire is again insulated from making contact with the frame of the bell, or the defective insulation of the binding screw repaired.

PUSH-BUTTONS.

Sometimes the contact spring becomes corroded and needs cleaning, or the wires at the binding screws become broken. Trouble at push-buttons is very seldom found, where the push-buttons are properly connected.

CHAPTER X.

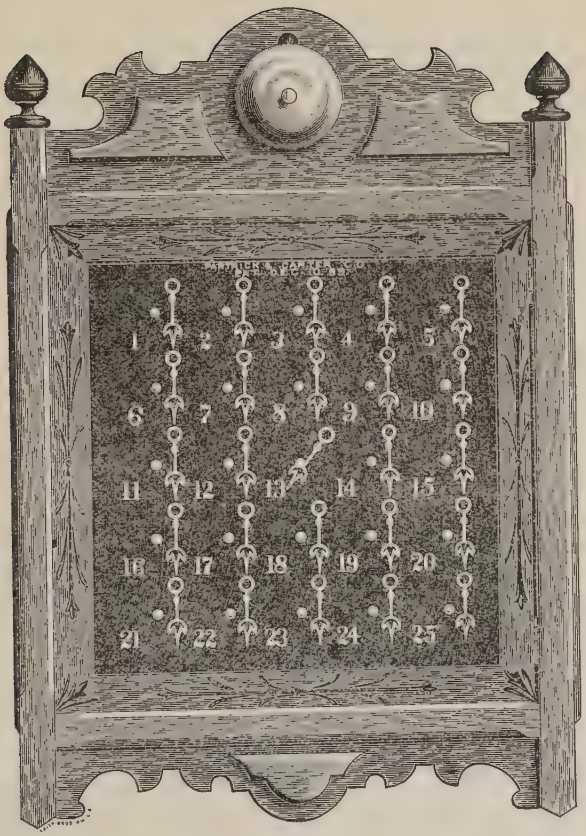
ELECTRIC HOUSE ANNUNCIATORS.

Electric Annunciators are used, where a number of signaling stations are all arranged to call or signal to one place. The Annunciator can be made for as many

indications as desired, and is so constructed that when a push-button is pressed, the bell on the annunciator rings, and an indicating needle, drop, or some other device will show from where the call, or signal came. There is but one bell to the annunciator, but the number of indications is never limited.

Plain house, or one way signaling annunciators, are constructed in several different designs. When an indicating device once indicates for a call, it should again be placed to its natural position. Some of the annunciators are arranged so that the indications are placed in their natural position by a mechanical device. Some are reset by pressing a push-button on the annunciator, and the resetting is done by electricity. Others are so made that the last place called or signaled from resets any indicating device that may be out of its natural position and leaves only the indication which was used or called last. They are called automatic re-setting annunciators.

On annunciators all wire connections are completed and a place provided for each wire that is to be connected. To wire for a house annunciator, the way to do is: have two colors of insulated wire, locate the place for the battery, run one wire from the battery to the last or farthest away push-button; then run one wire from each push-button outlet to this battery wire, and connect the wires together; make good connections. When all push-buttons have a battery wire, then run a second wire from each push-button to



HOUSE ANNUNCIATOR.

where the annunciator is to be located (run these wires all in one piece—do not have a lot of connections in them); when one wire is run from each push-button as described, the work is finished, as far as the push-buttons are concerned. Then run two wires from the battery to the place where the annunciator is to go, one wire of each color. In new buildings test the wires and be sure they are all right before leaving them. Have a battery and electric bell connect the wire that goes to all the push-buttons to the carbon side of the battery. Take a small piece of wire and connect from the zinc side of the battery to one side of the bell; from the other side of the bell connect one of the wires that go to where all the wires are, or where the annunciator is to be located. Have all wires free from insulation for a few inches at their ends; take the one wire coming from the battery, and touch each of the other wires separately, in case any of the wires to the push-button are crossed, the bell will ring; that is testing for closed circuits. Now take all the bare ends of the wire that did not ring, and tie or wrap them all together, including the wire from the battery.

Then go to every place where a push-button is to go, get the two ends of the wires together and the bell will ring (if the wires are all right). Should the bell not ring from every place, follow the wire from such places, and you will find a broken or disconnected wire on such circuit as does not ring; this is testing for open circuits.

Follow directions as regards iron and other pipes, solid walls, etc.; use good moisture proof No. 16 wire; by doing so you will never have any trouble with the wire work. By wiring so that you have two wires from the battery to the annunciator, either or any make of annunciator can be used; all annunciators have directions for connecting them to wires, when work is done so far, and no further directions are necessary here. Four cells of battery should be used for most annunciators; less battery may do, but four will be sure to give good satisfaction.

CHAPTER XI.

HEAT OR FIRE ALARMS.

For heat or fire alarms, where each room to be protected is to be kept separate, or where rooms in the same building are connected, in which the temperature varies, an annunciator will be useful. The wiring for the heat or fire alarm is done in the same manner as wiring for an annunciator. The wires should be run on the ceilings of the rooms, or building, and thermostats connected in multiples to the wires, in the same manner as push-buttons to ring one bell; the thermostats can be adjusted to close the electric circuit at different degrees of heat. In an ordinary room, used for any business or other purpose, the thermostat should be adjusted to a lower temperature than ther-

mostats used in boiler or engine rooms, laundries, kitchens, etc. By using several circuits and connecting an annunciator, the dangerous place can be well protected, and in case of fire the exact location at once known. Thermostats are made to close the circuit, the same as an ordinary push-button, and need very little attention when once placed. The temperature in a room becoming high, the contact points of the thermostat come nearer, when the temperature comes to the degree they are adjusted to, the circuit becomes closed, and an alarm is sent in.

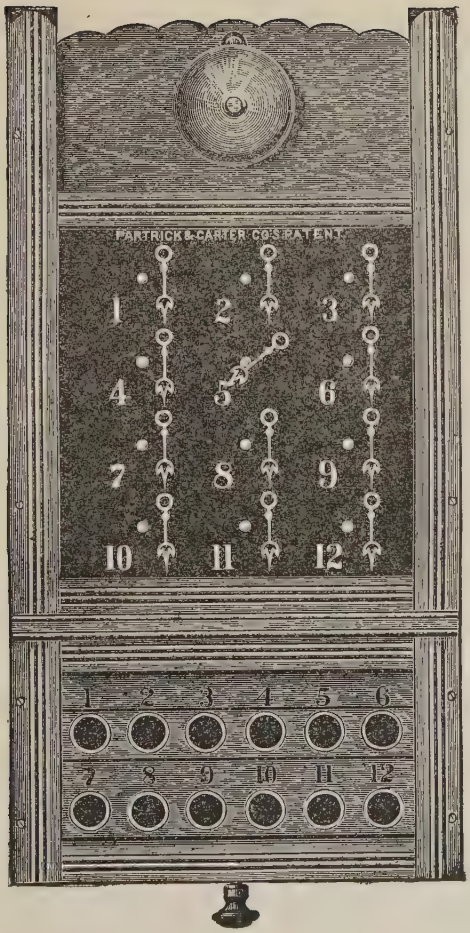
Such fire protection is not expensive, and is very much desired for most buildings.

CHAPTER XII.

RETURN CALL ANNUNCIATORS.

Return call annunciators are very much desired in hotels, large office buildings, and any place where signaling both ways is desired.

The annunciator has a set of indicating devices, and below these a set of push-buttons, which correspond to the numbers on the indicating arrangement. From an office where such an annunciator is located, a call can be made to any place connected, and should any one be there an answer is returned. In case no answer is returned, it is usually found that the person desired was not about at the time. These annunciators



RETURN CALL ANNUNCIATOR.

are also useful in case of fire, as all persons away from the office, where the annunciator is, can be called in a few minutes.

To wire for a return call annunciator, the best plan to follow is to use three colors of insulated wire. One wire, a red one, can be run from one side of the battery to all places where push-buttons are to be. A second wire from the battery (a blue wire), to one side of all the bell connections. These wires are run similar to the battery wire for an annunciator, each separate wire connected to one main line battery wire by a half connection. When these two wires are run, so that a red wire and a blue wire are at every push-button and bell outlet, the battery wiring is finished at these outlets. Now a third color wire (either black or white—these are the two best colors), should be run, one wire from each place where the two wires are, to where the annunciator is to be located; remember, one separate wire from each place to the annunciator. Should you wire for a fifty number annunciator you would have one red wire, one blue wire and fifty black or white wires at the place the annunciator was to be. Now, if you have to place the battery away from the annunciator, run two wires from the battery to the annunciator.

When three different colors of insulated wire are used, there should be no confusion when connecting combination bells and buttons at the different signaling stations; always connect the same color wire to the same spring, at each separate station.

CHAPTER XIII.

TROUBLE AND REPAIRING ANNUNCIATORS.

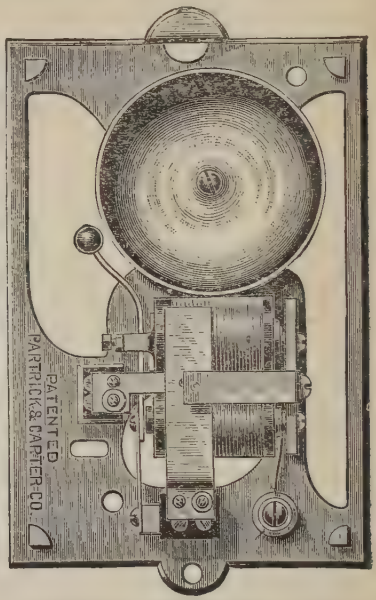
ELECTRIC HOUSE ANNUNCIATORS.

When a house annunciator will not work from any point, the battery will be found with a loose connection, such as a broken wire at one of the connecting places, a zinc eaten off, or the batteries out of water. One battery becoming dry, the circuit is broken the same as though the wires were cut. Get the batteries in good condition, all connections clean, bright and tight, and very little trouble is found. The binding post, or connection of the wire, from the battery to the annunciator at the battery and at the annunciator, should also be examined; also the adjusting screw, of the contact place between the armature and the bell; at either one of the places the trouble can occur. Never blame the wires for trouble of this kind in a properly wired building.

When only some of the indications are out of order the trouble will be found at the push-buttons, or at the contact places where the wires are connected to the annunciator; in such cases trouble is easily found and repaired. Return call annunciators, when no indications will work, look up the battery, etc., the same as for ordinary house annunciators. When only certain places, or a few places are out of order, examine the connecting place on top of the annunciator. The push-buttons, corresponding to the places which do

not work on the annunciator, and the bells. On large annunciators, the case, of the wood work, of the button board, will sometimes become warped; in such cases the warping of the wood will cause some of the

COMBINATION BELL AND BUTTON, COVERED.



COMBINATION BELL AND BUTTON, COVER REMOVED.

push-buttons to have an open circuit, the wood warping inward, forces the button to break the contact between the long and the short spring. Should the case warp very much, the long spring of the push-button might be shoved in far enough to make contact with the bat-

tery wire, in this case the bell from such button will ring all the time, until the case is opened or the wire disconnected. Button boards on return call annunciators have three contact places or connections to them, and all combination bells have also three connecting places.

All annunciators have an electric bell, which can cause trouble. See Electric Bell explanation and description, page 36.

CHAPTER XIV.

ELECTRIC BURGLAR ALARMS.

An electric burglar alarm annunciator is so constructed that all places connected with it will sound an alarm when the connected place is disturbed.

OPEN CIRCUIT.

These alarms can be either a closed or open circuit. The open circuit alarm is sounded when a connection is made, and is the style of alarm used in private residences.

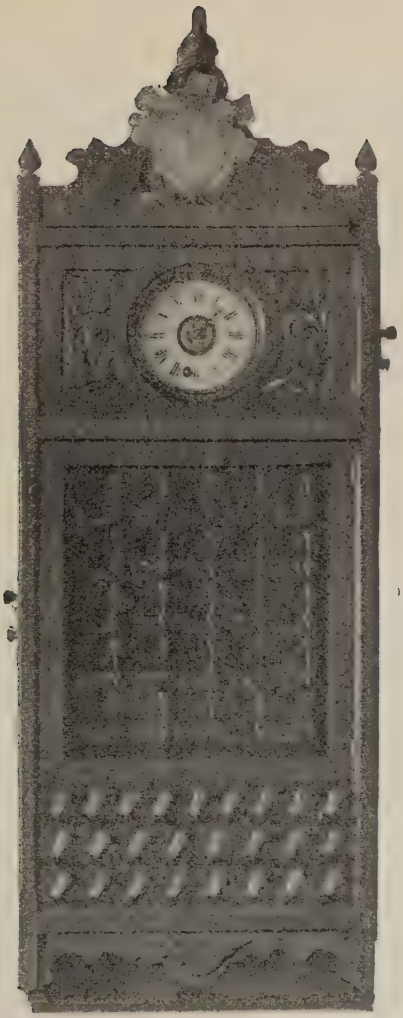
The closed circuit alarm is used where an office or place of business is to be connected, and the place where the alarm is to be sounded is some distance away. The residence or open circuit alarm is so arranged that it can be controlled by sections.

The burglar alarm annunciator used on open circuit work is so arranged by connecting and switching de-

vices that any part of a house, in which an alarm is connected, can at any time be easily disconnected, should there be any necessity for doing so. Should any connected door or window be opened when the alarm is set, the alarm will at once indicate the place, and the ringing of the bell at the alarm will attract attention. Should a connected window or door be opened and quickly closed, the alarm will indicate and ring, and keep on ringing until stopped at the alarm, by the resetting of an automatic device. The door or window which caused the alarm to ring, cannot stop the ringing by being closed. Should a door or window connected with an alarm not be locked, it is still safe, as the door or window cannot be opened when the alarm is on, without disturbing the indicating device, and ringing the bell. A burglar alarm is necessary in any large private residence, where servants are employed. The owner need not go through the residence every evening to see to the closing of all windows and doors properly.

The alarm will tell as soon as turned on, and will tell in just which room the door or window is left open. Where alarms are in residences servants are more careful, and the hours can be known when they come in or go out, when the alarm is on.

Where gas or electric lights are used for lighting, alarms can be arranged so that when the alarm is disturbed, it will at once light one or more lights. This is a valuable feature, as light is always a necesssity



ELECTRIC BURGLAR ALARM ANNUNCIATOR.

when an alarm is sounded during the night. The proper place for a burglar alarm annunciator is in the family bed-room, and so located that a good view of the annunciator is had from a lying position on the bed.

The battery for the alarm should be located in a closet, opening from the room in which the alarm annunciator is placed. When the battery is so located no fear need be had of any one ever meddling with it. The battery is the life and strength of the alarm, and should be in a good, safe and secure place.

To wire for an alarm, use two colors of insulated wire, by doing so confusion and mistakes are not very likely to occur.

A new building while being built, is easily wired for an alarm, and is wired as follows, viz:

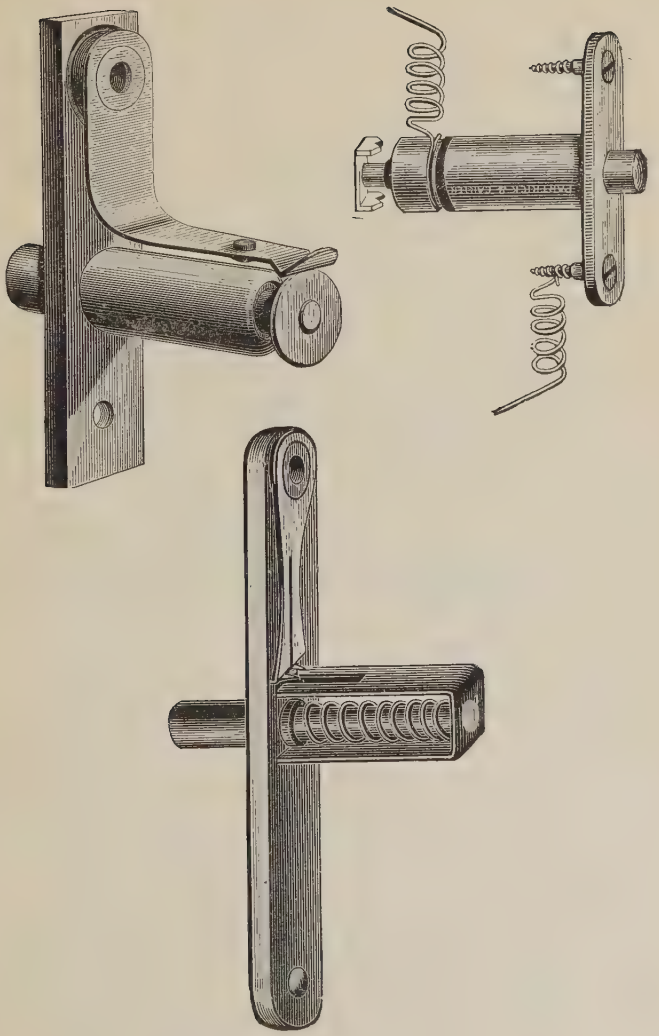
Locate a place for the battery; from this battery location run a main wire (in large buildings use a No. 14 wire, and in small buildings use a No. 16), through the building, from the battery. To this wire attach one wire from every door and window to be connected to the alarm. Where a door or window is to have a separate indication on the alarm annunciator this battery wire can be started at the place the spring on the door or window will be placed (the same as wiring for a push-button), and run to and connected on the main line of the battery wire. Where two or more doors, or windows, are to be connected, the battery wire should be run to a point, where a wire from each door

POSITION OF BURGLAR ALARM ANNUNCIATOR.

or window, can be easily brought, each room should be provided with a branch battery wire, before any other wire is run. A red colored insulated wire is a good one to use for the battery wire. When the battery wire is so far finished locate the place where the burglar alarm annunciator is to be placed, from this location run a separate wire to each place that is to have a separate indication on the alarm annunciator, viz: The parlor having six openings should have two separate wires, three openings connected to each wire.

The front door should have a wire by itself. The library having three or four openings should have one wire. The dining-room one wire, and so on, to each place to be connected; where the indication on the alarm annunciator is to have control of but one door or window, the wire should be run in one whole wire from the alarm annunciator to the door or window spring. Where two or more door or window outlets are to be connected to the one indication, the wire should be run from the alarm annunciator, to a good location near the door or window outlets that are to go on this wire, and left at this place. We now have the battery wire and the line wire, at each room having two or more doors or windows that are to be connected.

At all doors or windows which hang on hinges the two wires should come out of the frames so when the door or window is closed the spring is hid. The door



DIFFERENT STYLES OF DOOR SPRINGS.

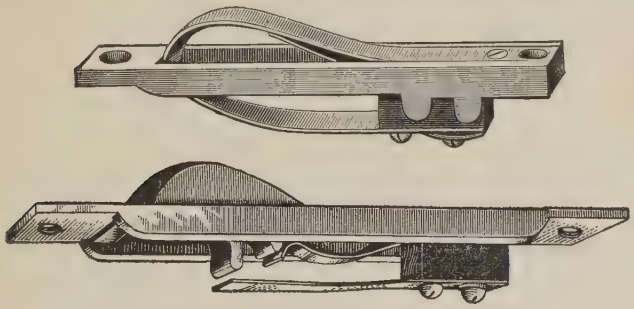
spring comes on the same side as the hinges come on; it can come below the lower, or above the upper hinge, and should not come out near the middle of the height of the door frame, as springs placed at such places are easily noticed. All alarm springs should be so located that they are not easily seen.

On windows where the window sash hangs on cord or bands coming from pulleys at the top of the window frames, or on any window frame having double sash, a lower and an upper one, the spring for the top window is located, so the lowest part of the window alarm spring comes about one half inch above the lower side of the top sash frame. The spring for the lower window sash comes, so the top of the window alarm spring, comes one half inch below the top of the lower sash frame. These sash alarm springs are mortised into the window frame, and on the inside where the top sash travels in; also on the inside where the lower sash travels in. The window sash is cut out, so the window can be raised or lowered for ventilation as desired.

The springs are so constructed that the raising of the lower window, or the opening of the upper window, presses in on the spring, making the same contact as a push-button on an electric bell circuit, when the button is pressed. This spring works through an automatic device on the alarm annunciator, which closes the circuit and controls the ringing at the alarm. The window can cause the alarm to ring, but cannot

stop the ringing when the alarm is started. The ringing must be stopped at the alarm annunciator.

The wiring at a window should come out through the casing board, that covers the box, where the sash weights are in. The wires should come out about six inches below the top of the bottom window sash. The hole in the window casing, or frame, should be made with a quarter inch or larger augur bit. The wires



WINDOW ALARM SPRINGS.

should never be in the box where the sash weights are in. When the wires are through the window frame, they should be so run that they remain loose down to the floor, and over to the place where they are to be connected to the main wires, each door or window spring has place for two wires to be connected to them, by using two different colors of insulated wire, one color for battery wire and a second color for the line wire, no mistakes can occur, as each color wire should be found at each connecting place. The same colors

of wire should always be connected together. Where no studding is on the walls, and plastering is done on the brick or stone, all the wires should be run in conduits, (no wires should ever be fastened in solid walls), and the conduits so run that wires can be shoved from a window or door spring, down to the place under the floor, or up to the space above the ceiling. Where two or more outlets are to be connected, run two wires from each place to where the line wires are left, when the outlets are wired, the connections for each set will be together; you then are sure of getting them all connected and in case of any of the wires becoming defective they are easily disconnected. All wires should be so run, from the outlets where the springs are, to the connecting place to the main line wires, that the wires could be removed and new wires pulled in, when the work is all finished. When burglar alarm wires are so run, no trouble ever occurs to them.

When the wiring is all done, as described, two more wires are to be now run from the battery to the alarm annunciator, this completes the wiring for the annunciator. Test all wires the same as testing wires for a house annunciator, keep wires clear from all gas, water or other pipes, both lead and iron; all tin or metal work; use no cheaper insulated wire, than "Damp Proof Office Wire," do not fasten wires with double pointed tacks or nails, as none of such fastenings are necessary; follow the rules for wiring for appliances using battery current, and your alarm wire work will never become defective.

On account of some persons desiring alarm springs placed so the opening of outside double window shutters will sound an alarm, it is a good plan to always bring the wires to the right hand side of all windows—(as you look out through them).

The door and window springs should be carefully put in, as most trouble on alarms comes from carelessly put in springs. Always have a fair space between the two points of contact on each spring.

CHAPTER XV.

CLOSED CIRCUIT ALARMS.

Two sets of batteries are required for a closed circuit alarm, one relay, one automatic drop and several switches. The alarm springs are so made, that to ring the alarm, the electric circuit has to be broken. When one spring is out of order, the whole system becomes useless. The only advantage of an open circuit alarm is, that, should the wire be broken, the alarm will be sounded. (On an open circuit alarm the breaking of a wire will not cause the alarm to ring.) Closed circuit alarms are used where a store or office is to be connected, and the alarm given in some other building. To wire for a closed circuit alarm a ground connection is usually made. Drive an iron pipe four or five feet deep into the ground, or if gas or water

pipes are near, use them for the ground connection. Attach one end of a wire to this ground connection run this wire to where the first spring is to be placed, run the wire from spring to spring until all the springs are wired. Closed circuit alarm springs are so made that the opening of the circuit breaks the electric flow sending in the alarm. From the last spring the wire runs to the place at which the signaling apparatus is to be located. Here connect the end of a wire to one point of the switch, and from the other point run a wire to the relay. The relay has four binding posts or places for wire connections—two of the binding posts for each circuit. By examining the relay on the under side you trace a small wire from one binding post to one or two magnets, and from the magnets the wire runs to a second binding post. The wire to the relay from the springs takes one of these binding posts; from the second binding post the wire should go to the copper side of a closed circuit battery, and from the zinc of the battery a wire is run to the ground connection. This completes the one part or circuit of the alarm.

When all connections on the alarm circuit are closed and the switch turned so that it is closed, the battery current will flow through the wire and the springs, coming through the coils of the magnets of the relay. The armature of the relay is drawn over against the magnets and remains there until the circuit is opened. The opening of the circuit, allows the armature to

move away from the magnets, by doing which a connection is made on the second circuit.

From the binding posts of the relay that are now still vacant, run a wire from one binding post to an open circuit battery; from the battery to a bell, from the bell to a switch, from the switch to the second binding post; the bell will ring at any time the circuit is closed and the armature of the relay is away from the magnets. In this way of connecting, the bell will only ring when the circuit of the first part is broken or open. To make the alarm as it should be a continuous ringing arrangement should be connected in the second circuit.

CHAPTER XVI.

WIRING OLD BUILDINGS FOR ALARMS.

The hardest part of the work in old buildings is to get the wires from the windows down to the floor. Remove the small piece of wood on the window frame, which holds the lower window sash in place. About six inches below the top of the lower window sash bore a hole through the window frame, through the board that makes the side of the box, where the sash weights are placed; make a one quarter inch or larger hole. This hole should be so made, that the bit will come into the opening behind the lath and plastering, and between the studding. Use a chain, a string, and

a small piece of iron wire; get the chain with the string attached through the hole, into the opening, and work enough string into the opening, so that the chain will fall down to the floor. When the chain is down, a small piece of floor board should be taken up, and a hole worked to come out, back of the lath and plaster, to where the chain and string are. The chain can now be easily fished out, remove the chain and with the string get the wires through and up to the window. In case the wire cannot be worked to the window as above described, take the small piece of wood from the bottom or sill of the window frame, make a small hole from this place down into the place below the window, use the chain, string and wire and do as described above. This can be done all right. The wires then have to be run up to where the springs are to be, by cutting grooves out of the window frame, under the small pieces of wood, which hold the lower window sash in place.

In places where there are heavy walls such as stone or brick, the window wiring is more difficult, the window frames are so far to the outside wall, that often trouble is experienced in getting wires up to them. Sometimes the wires can be worked down as described above, but not always.

In some cases it is necessary to take away the molding along the bottom of the window seat. This can be removed and carefully replaced, so as not to do any material damage to the molding. When this

molding is removed, no other trouble is experienced, and the wiring is an easy matter. The wire around under floors can all be easily placed, (see wiring old buildings for appliances using battery current) and the alarm finished in number one style.

Four calls of battery should be used to an alarm, and no other bell or annunciator work should be connected to this battery. In many places in wiring old buildings, the wires to the second floor windows are from the bottom of the windows to the floor; the first floor windows are reversed in the wire part, and wires run from the top of the first floor window frame up, to above the ceiling; this is easily done when the connected windows are in a line above each other.

CHAPTER XVII.

BURGLAR ALARM TROUBLE.

When a burglar alarm system does not work from any place, examine all battery connections, etc., the same as for house annunciators.

When one or two indications always indicate, the trouble will be found around the window springs. Window springs often become short circuited and cause the indicator, which represents the circuit they are for, to indicate. If the trouble cannot be found, throw off the switch on the alarm annunciator, which corresponds with the circuit out of order, and the

balance of the alarm can be used. On such trouble examine each window or door connection controlled by the indicator switch, and at one of these connections a defective spring will be found. By taking from the window frame the small piece of wood which holds the lower sash in place, the lower window sash can be removed. The spring which the lower window sash controls can then be easily repaired. The upper window sash, by being pulled down to the bottom of the window frame, leaves its window spring exposed, so that it can be taken out and repaired. When the springs are carefully examined, their way of connecting can be understood by any person of average intelligence.

This work is all very easily understood by any one who will become interested in electric work. A very little thought and study will make the whole system clear.

Should a burglar alarm annunciator ring, and no indication show, then the continuous ringing attachment on the alarm has closed the circuit. Always be sure to reset the continuous ringing arrangement, whenever the alarm has rung. When an indication on an alarm annunciator falls or gets out of its standard position, caused by the circuit being closed, it always connects a continuous ringing arrangement: This continuous ringing arrangement must be reset every time it is thrown, or the alarm will ring, and no indication will show what causes the alarm to ring. Every burglar alarm has a continuous ringing attach-

ment. When any circuit to the alarm refuses to ring, look up its connecting place at the alarm annunciator; the trouble will very often be found there.

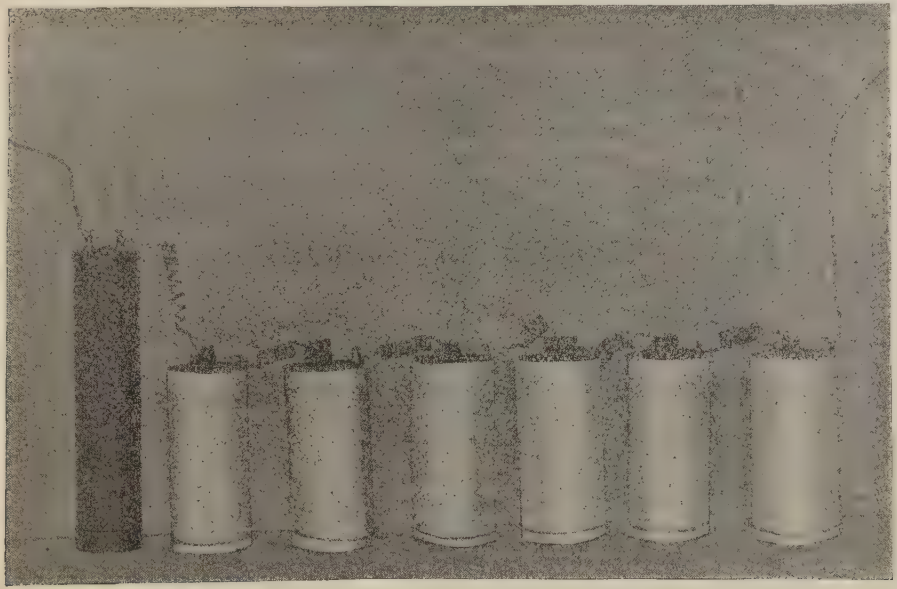
On all alarms, carefully wired for, having only a few outlets to each indication, trouble rarely occurs. All alarm work should be done (when you are paying for it) by men of experience in alarm work: do not give a man your alarm work to do who cannot show some other work of the same kind done elsewhere and recommended. All alarm annunciators can have trouble at the bell by loose connection, etc. (See Electric Bell description on page 36.)

CHAPTER XVIII.

ELECTRIC GAS LIGHTING.

One of the conveniences controlled by electricity, and very much desired by every one who uses gas as the means of lighting. To wire a building for gas lighting is not much of an expense, and the convenience of lighting a gas jet without having a match or lighted taper, is not an expensive luxury. For gas lighting work, locate the battery (one of six cells) in the cellar, at some convenient and light place, or near where a gas jet is placed. Connect a wire to a ground connection, usually to the gas pipe. Make this connection good and long, on a good, clean, bright spot on the pipe; use a file if the pipe is black, and file it

bright. This wire connection should be soldered. This ground wire should run from its ground connection and connect to the zinc pole of the battery. From the carbon side of the battery a wire should be run to one side of the spark coil; from the opposite side of the spark coil a wire should be run to a closet or some handy place, to which a number of wires can be brought. When the place is located and the wire from the battery is run to this place, run a separate wire out to every center or drop outlet in the building; also run separate wires to all side or bracket outlets in each room, one wire for all the brackets in each separate room; bring the wires out at the side of the gas pipes, and about one inch away from them, at the place where they come out through the wall. Never run the wires along by the gas pipes, under the floors, or down partitions; where pipes are in the space between two floor joists or studding, bring the wires along in the next space, and do not allow the pipes and wire to come in contact. Treat the insulated wire as though it had no insulation at all pipes; when this is done, no trouble will occur to the wiring; all outlets so wired, with one wire, can be used for the different make of pendant and hand-lighting burners. To wire for automatic burners, we will locate the places at which we will place the buttons that are to control the lighting of these automatic burners. When the buttons are located, we run a wire from where the switches are to be located to each of the places where buttons are to

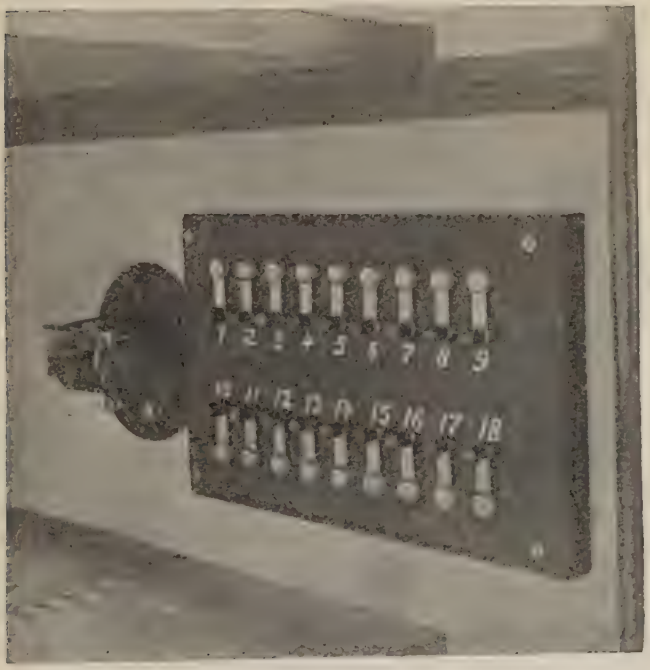


SPARK COIL AND BATTERY ON GAS LIGHTING.

be, in the same manner as we would wire, were we going to have gas outlets where the buttons are being located. This is the battery wire to the push-buttons. We now run the wires from the buttons to the outlets where the automatic burners are to go, two wires from each button to each place where the automatic burner is to be. In case one automatic burner is to be controlled by two or more places, we will finish the automatic wiring to each one as we go along; from a second button we run two wires, and connect them at the most convenient place to the first two wires which go from the push-buttons to the automatic burner. Finish all the wiring to the one automatic burner before commencing to wire for the second one. By following this rule you will never lose your wires, nor get wires connected improperly.

A building can be wired in this manner for as many automatic burners as desired to be controlled by any number of places. Usually automatic burners are only used in halls and cellars. An automatic burner in a cellar, which can be lighted before going into the cellar, and put out when one is out of the cellar, is a convenience not to be despised by any one. At the place to which all the wires come a switch board should be provided for each wire, so that any circuit could be cut out, if it is desired to do so. The battery wire comes to one side of every switch; the opposite side of the switch has a wire to some outlet, connected to it. When trouble occurs on a gas-light-

ing plant, so constructed, it takes but a short time to locate and repair it. The wire coming from the battery can be connected through an automatic circuit

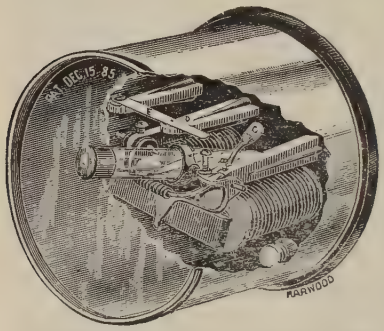


AUTOMATIC CUT OUT AND SWITCH BOARD.

controller, which should have control over all outlets, so that when a burner becomes grounded, the automatic cut-out will save the battery from being run down. When batteries have had a few short circuits

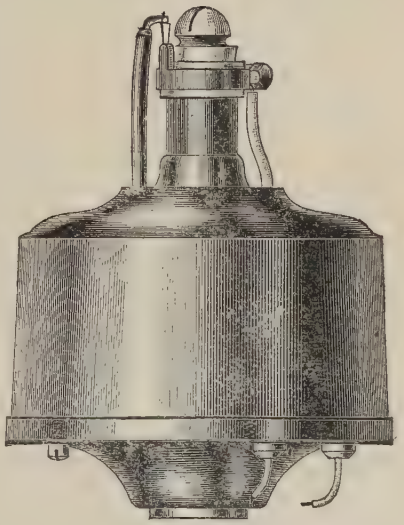
of any duration, they are worthless, and new batteries have to be used.

Automatic burners are so constructed that two push-buttons are used to operate them. Pressing one button turns on the gas and lights it; pressing the second button turns off the gas. When the first button is pressed, the electric current follows the wire to the burner, goes around two magnet coils, and follows a fine magnet wire to a brass collar, which is fastened at the tip of the burner; this collar has a small projecting point, against which a small brass rod or electrode presses, when the current is flowing around the magnets, caused by the pressing of the white button, an armature either on top of, or below the two said magnets, is attracted to the magnets. This armature controls a small valve in the stem of the gas burner; one press of the button turns on the gas; at the same time the armature which is attracted to the magnet, breaks the circuit at the contact point of the two electrodes, at the tip of the burner, which causes an electric spark. This spark lights the escaping gas.



AUTOMATIC CUT-OUT—PLAIN VIEW.

By a constant pressure of the white or lighting button the armature vibrates, and the spark at the tip of the burner is like a flash light, and remains so until the escaping gas is ignited. The pressing of the second or black push-button allows the electric current to follow a second wire to and through a second set of magnets, to a ground connection. The electric current, in passing, around the second set of magnets, attracts an armature, which turns off the gas.

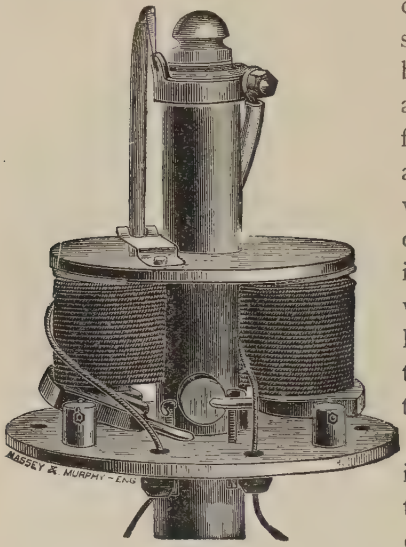


AUTOMATIC BURNER—COVERED.

For wiring gas fixtures where electric gas lighting is used, you should have a wire called chandelier wire. This wire has a triple insulation. When used on side lights or brackets, and on arms of fixtures, it should be run so that it is not easily seen. Tie the wire on the fixture by wrapping thread around the fixture and wire, in a spiral manner. When chandelier wire is fastened on the fixture, use white shellac on the wire where it rests on the fixture; two coats of white shellac

and a few days time, and all the thread can be again taken from the fixture, the shellac will glue or fasten the wire, so that it will remain, unless pulled off intentionally.

In wiring chandeliers the wires can generally be concealed, down the stem to the body, between the gas pipe and the outside or finishing shell. In all cases where the wires are so placed, do not depend on the insulation of the wire; use some insulating tape, and tape the wires well where they are between the gas pipe and finishing shell; also use tape where the wires come out through small holes, through the casing or finishing shell. All seating rings, plates, bodies and pieces of the finishing shell, should be filed, so that they will easily slip over the wire. Too much care cannot be taken where fixtures are wired concealed.

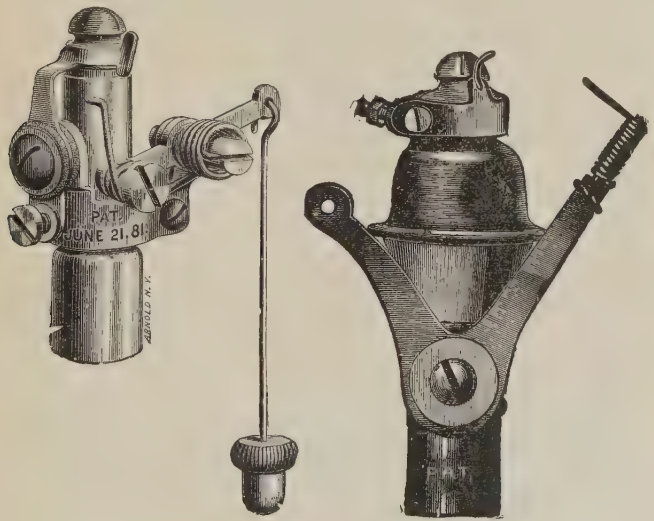


AUTOMATIC BURNER—UNCOVERED.

When wiring combination fixtures (fixtures on which gas and electric lights are used) a ground wire to the

gas or other pipe must not be used; a return wire must be run, and all burners should be insulated from the fixtures by hard rubber nozzles or bushings.

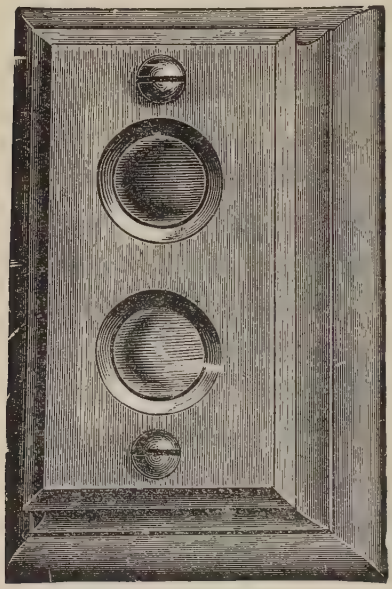
To wire for electric gas lighting, it would be better to do all wiring on metallic circuits, using two wires and no ground connections. Very often ground con-



PENDANT OR HAND-LIGHTING BURNER.

nections occur which could be avoided by using a return wire. This return wire should run from the battery (the zinc side) in place of the wire to the ground, and should be run to every outlet; all outlets would have two wires for pendant or hand-lighting burners, and three wires for automatic burners. All

wires should be run in one piece or length, and as few connections made as possible. A connected wire is never as good as one without connections, for any and all electrical work. Wherever wires must be connected all connections should be soldered, wiped clean from acid, and again insulated.



PUSH-BUTTON FOR AUTOMATIC BURNER.

All pendant or hand-lighting burners have a binding screw where the wires are to be connected to them. All automatic burners have two connecting wires or binding screws. When the wiring is done, the putting on of the burners and connecting them is a very simple matter.

For pendant orhand-lighting burners, one wire is run down the stem of a fixture; in the body of the fixture each arm which is to have a gas lighting burner, has a wire connected to this one main wire; and the wires run so that one wire comes out over

each arm that is to be provided with an electric gas lighting burner. At the end of the arm, where the burner is to be placed, a small coil should be made on this wire, having spare wire, so that in case of wire breaking or insulation becoming defective on the fixture, it need not be rewired. To connect this wire to the hand lighting or pendant burner, put the burner on the fixture good and tight before connecting the wire to the burner; an insulated collar or connecting screw will be found on each of such burners, to which the wire is to be connected.

CHAPTER XIX.

ELECTRIC GAS LIGHTING TROUBLES.

On electric gas lighting very much trouble can occur. All wiring, especially fixture wiring, should be done carefully and in the best and safest manner possible. When wiring fixtures, do not be sparing of insulating tape; do not, where the wire touches sharp edges, have the wire tight; one sharp place partly cutting through the insulation of the chandelier wire, can place an escape or slight ground on the system, which will affect the battery. This one place can be a detriment to the whole of the gas lighting plant. When a battery for a gas lighting plant needs much attention, look for escapes or slight grounds on the system.

Buttons for controlling automatic burners should have a good clear space between the contact points of the springs. The wires back of the push-button should not be crowded and press against the springs when the push-buttons are fastened at their places.

AUTOMATIC BURNERS.

There are only a few places about automatic burners which are likely to give trouble—at the contact point between the collar electrode and the electrode controlled by the armature, (the place of sparking and lighting the gas) should be bright. When an automatic burner refuses to work well, carefully clean this point of contact, and very often the trouble will then be removed. This electrode controlled by the armature, sometimes on some make of burners, gets bent; it should always be in a free working condition. The small valve in the stem of the automatic burner sometimes becomes dirty and refuses to work well; this can be easily remedied by taking the burner from the fixture, hold it up, and drop one or two drops of kerosene oil on the valve. By working the armature with the fingers, the oil will loosen the valve and remove the trouble. Never handle automatic burners roughly, always carefully.

Do not try to take the valve out of the stem of the burner, nor try to take the burner apart. When the valve is taken out, it is a difficult matter to again replace it so it will properly turn off the gas.

When a burner gets in such a condition as not to be easily repaired, it is best to send it to the factory and have it given a general overhauling; the burners will then be returned as good as new, and at very little expense. Pendant or hand-lighting burners are seldom troublesome, except at the electrodes, where very often severe grounds occur. When the electrodes become black by the heat of the gas flame, they should be cleaned; this can be easily and quickly done by filing them with a small file or with emery cloth. In time the springs on the burners become weak; if such is the case, they should be replaced with new ones. Keep the electrodes and springs in good condition. The valve of the pendant burner can be easily taken out of its place and cleaned. Whenever it becomes necessary to clean pendant or hand-lighting burners, remove them from the fixtures.

The valve which controls the gas can be easily removed, by taking out one or two screws. Hand-lighting burners are very simple and are easily understood by any one.

CHAPTER XX.

WIRING IN APARTMENT HOUSES AS USUALLY DONE.

A great deal of wiring in apartment houses is unsatisfactory. A small, poorly insulated wire is usually used, and the work is done imperfectly, by inexperienced mechanics or men having no conscientious

ideas of doing electric wiring properly. Most trouble occurs where the wiring is done in this way. Bells in each apartment to ring from front vestibule; bells in each apartment to ring from the basement; push-buttons in each apartment to control an electric door-opening lock, and very often buttons in private halls to ring a bell in each apartment, when these four different appliances are all connected to one set of main wires from the batteries, and these wires being of the smallest size and cheapest possible insulation. Another cause of trouble from imperfect wiring arises where the wires run among speaking tubes (usually tin), gas, water or steam pipes. In such cases, it is no surprise that mechanics, calling themselves electricians, are constantly engaged in repairing.

Wires running along steam or hot water pipes can, and often do make battery trouble. A damp pipe will injure the insulation on a wire to such an extent as to cause a drain on the battery. The two main battery wires, namely, the carbon and zinc, or the positive and negative wires, should not come in contact with either hot or cold pipes. Often also such pipes are moist or damp, and moisture or dampness is known to be sure drain when they come in contact with the wires.

The material and the wiring throughout are of the cheapest kind; iron box bells, with poor insulation at their binding posts, connect the wires from the magnets to the main wire, and also from the magnet to

the adjusting screw of the armature spring. These are both important places, and poor insulation is detrimental to bells thus wired. Where such bells are used (bells costing 30 cents and less), it is impossible to keep them in proper working order for any reasonable length of time.

Push-buttons in letter-boxes, generally having very little space between their springs and contact device, are also often of a cheap pattern.

The entire system of electrical appliances, from the wiring to the appliances, is done in the cheapest manner possible Usually it is competition work—the lowest bidder securing the work. To protect themselves these low-priced men do not have any intention to do good work; they make all they possibly can out of the contract. The owner of buildings not being familiar with the work, does not know how the work should be done to be good; they can not see that poor material is used and that the work is constructed in a poor manner. He first discovers it after he has to pay bills almost continually for repairing. Owners of such buildings should employ a competent man of experience to draw up specifications and inspect all his electrical work as it is being installed. They would then not be at the mercy of such persons, who are neither conscientious nor honest in their work. Dealings with persons who are not educated in the manner of doing electrical wiring should be avoided. Owners who employ incompetent men have

to pay in one of two ways, namely, either by being cheated or by continually paying bills for repairing, or by paying some one who does understand how the work should be done.

This is a branch of work which should be entrusted to a practical and experienced man. Many men would be willing to look after such work who are wholly ignorant of the work. A skillful and honest man of experience is the man desired.

CHAPTER XXI.

WIRING IN APARTMENT HOUSES. HOW IT SHOULD BE DONE.

The location of the battery should be first considered. The battery should be in a place easily reached, where water is convenient, and good day light or gas jet near. It should also be in a place where not much air draughts will get at it, or secured in a good large and tight box. No smaller size than a No. 16 wire should be used, and a good insulated wire; none of a poorer insulation than Damp Proof Office Wire. All separate appliances should have a separate set of wires to the battery, such as door bells from front doors, one set; inside or private hall bells, one set; bells in janitor's room, from push-buttons in kitchen, one set; bells from speaking tubes in basements, one set; electric door openers, one set. These separate wires should

come to the battery location, and be marked so that they can be easily separated.

In buildings wired in this manner, and having much trouble, the circuits could be connected to separate batteries, and the trouble, drain or short circuit, easily located. The cost of running separate battery wires as described, would amount to very little; a large building would not require more than 1000 feet more wire than is usually used; the cost of 1000 feet of damp proof wire No. 16, would be no more than five dollars; the extra work to place this wire as described would not take more than one-half a day's time for one man; the whole expense would not be more than ten dollars to the owner. The amount of time saved in looking for trouble would balance this amount in two years or less; after that time it would be all gain to the owner.

HOW THE WIRE SHOULD BE PLACED.

The wires should run clear of all tin tubes, iron, lead, brass or other metal pipes. From the letter boxes and push-buttons at the front doors, the wires should not go to the cellar. The wires should go up to the floor joists, of the first floor ceiling. These floor joists should have holes through them as described in wiring new buildings for electrical appliances, using battery current, pages 1–5.

The holes should be made to easily receive the wires intended for them, and far enough away from the

ceiling and floor side of the floor joists, so that the nails from the floor boards, or lath, can not reach the wires.

Where wires go up or down in partitions, they should never go in the same place or space with tubes, pipes, etc. There is always plenty of room, and a space next to the one occupied by tubes, pipes, etc., which could just as well be used; wires should be so placed that no plastering can injure them, and where they go in partitions, they should be arranged so as to stay in the center, of the depth of partitions.

A few pieces of wood nailed in the partitions, between the studding, having holes bored through such pieces of wood, will keep the wires in place; where wires go through floors they should be protected for six inches above the floors from the plaster which accumulates at such places, when plastering is done.

Bells and push-buttons can be located any where, and wires brought to such location, without wires coming in contact with speaking tubes, etc.

Keep all wires out of the cellars; use good insulated wire, also good push-buttons, having good contacts, heavy springs, and a good space between the springs. Use well made bells, uncovered ones, for covered bells are the abiding places of roaches or water bugs; have the work done with good material and competent men. Your bill for repairing will be a surprise, to others who employ incompetent men, who claim to do good work with cheap material.

When any one tries to convince you that any thing will do, lookout for a dishonest piece of work; good work, good material and good men are worth a fair price, and the person who pays for such is the gainer in the end.

CHAPTER XXII.

BATTERIES.

Each battery should be tested before being connected to any circuit; the testing is easily done by having an electric bell convenient.

When batteries are to be connected, attach the carbon side of one battery to the zinc side of the next one; follow this way of connecting on any number of them, and when a number of batteries are connected, there will always remain one carbon pole and one zinc pole, to which to connect the line wires.

Examine batteries occasionally, to see how they are working. Should the zinc of a battery eat away fast, the battery is doing a good amount of work. Keep the zinc clean, and if it can be conveniently done, they should be amalgamatized once a year. This will assist to keep the battery in good strength. Do not fill the jars with salamoniac; all solution will only dissolve to a certain density; the balance of the salamoniac lies on the bottom of the jar and is an injury instead of a benefit. A strong solution having a small quantity of salamoniac in the bottom of the

battery jar, is what is wanted. When the carbon side of a battery gets crystalized, it should be taken out of the jar and thoroughly cleaned. Batteries which do this when only used a short time are having too

NUMBER ONE
DRY BATTERY
THIS IS AN OPEN CIRCUIT BATTERY AND MUST NOT BE USED FOR CLOSED CIRCUIT WORK.
PARTRICK & CARTER CO.
PHILADELPHIA.

DRY BATTERY.

CARBON CYLINDER BATTERY.

much work to do. The wiring and push-buttons should be well examined, the cause found and removed or repaired. Always look for battery trouble on the wires from the batteries towards the push-buttons. Batteries should be so placed, that neither air

draughts nor heat can affect them. Both these cause evaporation, and where evaporation of the liquid is severe, the batteries will generally be coated around the jar, and look as if they were frosted. When it becomes necessary to renew the solution, pour all the old solution away, and clean all parts well in warm water. When charging an open circuit battery, use soft or rain water. Six ounces of salamoniac to each jar or cell; when the carbon and zinc are in the jar the water should be kept at least one inch below the top of the carbon side of the battery. Keep the batteries in a clean place, where they can easily be reached, and so boxed up or covered, that they will keep clean. When connecting new sets of batteries, clean all the connecting places of paraffine, and make all connections tight. Batteries for electric gas lighting, are the most troublesome, and should be frequently looked after; once in three months not being too often. Keep the batteries in good condition; do not let them run down; when they appear to be doing too much work, look for a leak or escape somewhere, a partial short circuit or ground. When

POROUS CUP BATTERY.

no drain is on a battery, the battery should last on ordinary work, for from four to five years. In that time it will need perhaps one or two good cleanings and renewals of salamoniac and water, perhaps also new zincs. The carbon side of the battery should last for such length without any perceptible difference in strength.

When cleaning and renewing a set of batteries, test each battery separate; should any of them not be good, do not connect such battery again into the circuit as it will only be an injury to the other batteries.

Sometimes the zincs in batteries will be found nearly or quite eaten off at the top of the solution in the jar. When examining batteries, lift the zinc rod and see that it is in one piece, change the height of the water in the jars once in three or four months, and the zincs will do better and not get eaten off.

Very many batteries are provided with covers. When cleaning batteries which have covers, be sure to wipe them perfectly dry, before placing them in position; also have the carbon and zinc dry wherever the cover touches them, before placing the cover on the battery. Covers are desirable where batteries are in a dusty or warm room or place where they are subject to draughts of air. In case no covers are provided a very good, in fact the very best kind of cover can be made with a piece of stiff paper, cut it to fit inside the glass jar, and cut out around the zinc

and carbon, to fit them tight. Let the cover extend down about one quarter inch below the top of the jar; now have some melted paraffine and pour it over these covers. This will make an air tight cover for the battery, and will not allow of any evaporation taking place. Such a cover is easily taken off by the use of an ordinary pocket knife, cutting around the place where it touches the carbon and zinc poles of the battery and the jar.

CHAPTER XXIII.

REMARKS.

In these remarks I will endeavor to explain the reasons why some materials should not be used and why work should be done in certain ways.

On account of the way it is insulated, common annunciator or burglar alarm wire is not safe to use in most places. Where the work is subject to dampness, the insulation will become moist. Should two opposite wires from a battery be near or against each other, as is often the case, the moisture will act as a partial conductor, and the electric current will flow out along the one wire to the damp or moist place, cross over through the dampness to the second wire, and a steady drain on the battery will be the result. Where such a wire is used, around brick, stone, or

iron work, of any kind, the batteries are sure to become troublesome in damp weather; by watching the batteries, the results of such material will soon be found; all wires should be damp proof.

Size or thickness of wire. No wire of a smaller size than No. 16 should be used; the resistance to be overcome by the battery current, before its intended work is done, is varied by the size of wire used—the higher the number of the wire, the smaller the diameter of the wire becomes. The smaller the diameter of the wire, the more resistance to be overcome by the battery current. A wire having a small diameter is easily broken, and all chances of having broken wires in electric wire work should be avoided. Where long distances are to be connected, by using wires of larger diameter, the amount of battery can be reduced. A wire having a small diameter, on long spans, besides being easily broken, requires more battery power, to give the desired result. The heavier the wire the better the result.

Never make large holes for wires. In cases where large holes are made for wires, there is danger from trouble of the insulation of the wires being worn away, by mice finding the holes and working their way through them. Most buildings are frequented by mice, and they will get all over a building if they can possibly do so.

In my experience I found a large hotel return annunciator, so crossed in its wiring, that it had become

useless. When a button at the annunciator was pressed, any number of bells would ring. The trouble was found under the floors, at the wires; where the holes were full of wires, the insulation was all right; where the holes were only partially filled with wires, the insulation on the wires was worn completely away, for a length of one inch or more, on each side of the floor joists, and also where the wires were in the holes. Between the floor joists, the insulation was not disturbed. Had the mice eaten the insulation, they could have easily eaten it from the wires between the floor joists, the wires at such places lying on the plastering under the floors. The insulation was worn away, either by the claws of the mice while crawling through the holes, or eat away by the dirt from the bodies of the mice, deposited in the holes, and among the wires, when the mice crawled through the holes. By having small holes so that mice cannot get through them, or having them full of wires, this risk can be avoided.

WIRES ON CELLAR CEILINGS.

Never have any wire on the cellar ceiling in new buildings while being built. The wires are not in place there; they are no ornament; they are easily and often broken; they become loose if fastened with cleats, unless they are fastened every foot or two of their length; the cellars are often white-washed, and the lime is no benefit to the insulation. All cellars are damp at certain times, and dampness will in time

cause trouble to the battery. In old buildings, wiring in cellars is sometimes done, the less done however the better the result secured. Wiring for a door bell in an occupied house the wires are better in the cellar than by being fastened with double pointed tacks around the wood work in halls, etc.

WIRES IN SOLID WALLS.

Where wires are placed in solid walls, and the plastering placed over the wires, the insulation of wires so placed will in time be affected and weakened. The action of lime or cement in plaster will eat away the insulation of the wire, and battery drains will be the result. A few years ago, electric light wiring was permitted, through such walls, by the use of a conduit, made principally of paper and asphaltum. Where this conduit was placed in such solid walls, it was at many places found eaten away, and only the hole remained in the wall, where the conduit formerly was. If the action of lime and cement will eat the conduit, when so placed, it will surely eat the insulation of the wire. The style of conduit formerly used has been improved upon, iron armored, and brass armored conduits having taken its place.

NAILS OR DOUBLE POINTED TACKS.

These should never be used directly against the insulation of any wires; they will rust and cause trouble. Where they are used, the work may be satis-

factory for a long time, but they will however cause trouble in time, and as wires can be held in place without being in contact with them, they should be avoided.

WIRES OVER FLOORS AND UNDER CARPET.

This style of work should not be allowed. Where wires run on top of floors, they are a detriment to carpets, and the cotton or other floor paper on the floor; they cause weak places and ridges in paper and carpets. The insulation of wires so placed is injured by being walked on. When carpets are being taken up, the wires are often broken; when cleaning is being done they are often water soaked, and very often broken; when broken they are often loosely connected, loose connections become corroded, and offer high resistance to the battery current. When the carpets are laid, often a tack will cross two wires, and either cut off a bell, or cause one to ring. Again, a tack may cut one wire and damage a circuit so that it cannot be used; the carpets must be again taken up, and the broken wire connected.

CONDUITS IN SHORT PIECES.

Conduits should always be so constructed that no mortar, dampness from the mortar, or any other obstruction can get into it. Always run the conduit in one continuous piece. Should two pieces be connected have them tight; take no chances at all; at open ends

of conduits where they run downwards; have plugs in the holes, so that no dirt or mortar can fall into them. Always leave the wires out of the conduit until the plastering is done; should any mortar get into conduits having wires in them, the wires and mortar dry together, and generally neither wire nor mortar can be removed. Conduits are meant as raceways for wires, and not for insulation.

A complete system of conduits for any kind of wire work is desirable. On account of the expense connected to a complete conduit system it is very seldom used for bells, alarms, etc. It should be installed by mechanics of experience, and so installed that any wire or wires that the conduit contains can be easily drawn out and replaced.

Conduit systems are the very best style of doing any and all electrical wire work. For appliances using battery current, they can be dispensed with; they are however a great benefit to such work, and where the expense is not too much they should be used.

INCANDESCENT ELECTRIC LIGHTING.

This style of wiring should all be done by the conduit system; it is the only safe way to install electric light wiring. Any new building properly conduited will seldom or ever have much trouble to contend with, such as open circuits, closed circuits, leaks, grounds, etc. They should always be installed by experienced mechanics.

CHAPTER XXIV.

ELECTRIC LIGHT WIRING, FOR INCANDESCENT LIGHTING, MOTORS, FANS, etc.

LIGHTING BUILDINGS BY ELECTRICITY.

This method of lighting buildings has become very popular, nearly every town of any reasonable size having an electric light plant. The desire of builders, contractors, mechanics and the public in general to become familiar with electric lighting is universal. It would be well if all persons were more familiar with the method of doing electric light wiring as it should be done. Would such be the case, all electric light wiring would be done in a better manner than is usually done, and many of the self-styled electricians would be unable to secure work which they do not know how to do properly. A man who pays for his wiring should have only the best, and the best is not above being improved at this present time.

The wiring as done now (1896), is divided into several systems, among which are, Iron Armored Conduit, Brass Conduit, Flexible Conduit and plain wiring for concealed work. The open or exposed work is either in moldings made expressly for electric light wiring, or the wires run exposed and fastened, so as to have an open space all around them, fastened by porcelain knobs or porcelain cleats. These knobs and cleats are so made, that all wires fastened by or with them have about one-half inch air space nearest the

walls, or to whatever they are fastened. In wiring a building, the first part of the work usually considered is the main line, or supply wires, to carry electricity for all the lighting in the building. In very many cases these main wires, especially in residence work, are never of sufficient size to carry the electric current to all the lamps in the building, should they all be in use at one time; it is especially so where alternating current, having a pressure of fifty volts, is used. The main line or supply wires should be placed from the place of entrance of current into a building, to a distributing center, where the building wired is not too large. This distributing center should be placed as near the center of the building to be wired as it is possible to place it. The main line or supply wire should be of such size as to carry, without any loss, enough electric current to supply 25 per cent. more current than is at first required. As time passes, some work is added, and in a few years the mains are too light to supply a sufficient current, when all current using devices are in use.

When a building having 60 lights is wired, and the main line run so that it will supply only 40 lights, the lights, when they are all in use, are none of them satisfactory, as each lamp is added above the number which the supply wires can properly carry, the lamps on the whole system become dimmer, the main line or supply wires begin heating, and at the terminals the heating often becomes so severe that the fuse wires

are melted out. The size of the main line wires are determined when the number of lights, the distance to be covered, and the pressure of the current to be used are known; the main line for the same number of lights is not always the same.

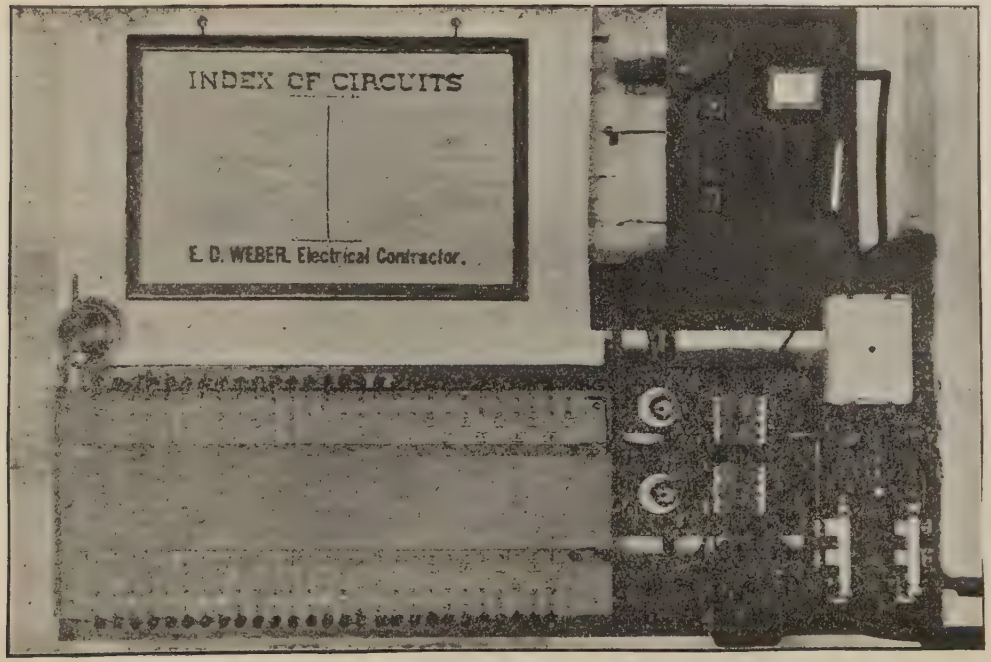
Persons desiring to become familiar with this matter will find a number of books on carrying capacity, etc., which can be secured at reasonable prices from any stationery or book store.

All main line or supply wires should be run separately, and plenty of space be kept between the two wires; when such wires are of large size, a cable or stranded conductor is easiest handled. The cost of a flexible or stranded wire is only a few cents more per pound than the solid conductor wire; the difference in the price is always gained in the time saved when placing the wire in position. All main line or supply wires, on a two-wire system, each wire should be of the same size. All wires on a three-wire system should be so arranged that the middle or neutral wire has as much copper or carrying capacity as the two outside wires combined, namely, should the two outside or the positive and negative wire be No. 6, carrying capacity 46 amperes, the central or neutral wire should be a No. 2, carrying capacity 83 amperes. This is necessary, in order to conform with the rules of the fire underwriters. At all places where wires enter buildings, there should be a switch or cut-out device arranged, so that all the wire can be discon-

nected at any time it may be necessary to do so. The switch should always be heavy enough to carry safely as much current as the main line or supply wires carry.

All main line or supply wires should terminate at centers of distribution. Here the sizes of wires change and all wires have places arranged so that only a certain amount of current can be supplied to the branch wires. This current must enter the branch wire through some safety device, (at the present time fuse wires), which are expected, and should become broken, when more current is supplied over a certain set of branch wires, than the branch wires are gauged (in amperes) to carry. The main line or supply wires should not run (as is too often the case) from their place of entrance to a meter [where meters are used], and then travel along, and at every convenient place for the branch wires, a branch block is connected, through which the branch wires are supplied. In such cases the branch blocks are located all over a building; when one circuit becomes defective the block which has the fuse wires melted or broken, can only be located after a long search. This used to be the way work was done; but in all good work the branch blocks, if any such blocks are used, should be grouped at one place, and each branch block should be marked with the size of fuse wire to be used or the size of the wire on the circuit should be given.

A better way is to have one main distributing center



MAIN DISTRIBUTING CENTER.

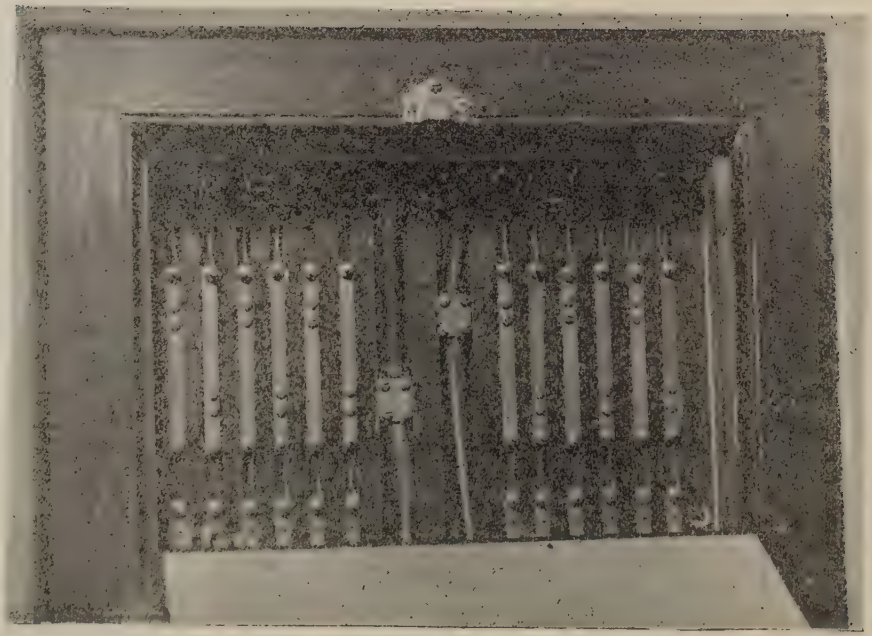
made, to accommodate all the branch wires, locate this center in a good, light and dry place and at a place easy to get to; number the circuits at some place above or aside of the distributing board; have a tablet made, telling where the circuits go and how many lamps supplied by each separate circuit; also give the size of the lamps, where lamps are not all of the same size. This will be so plain, that any one able to read can know what the distributing center is intended for. At all distributing centers the wires should be well secured; at such places close work is done, and too much care cannot be taken. Where a two-wire system is used, the distributing center can be arranged so that all wires to one side of it are positive, and all wires on the opposite side are negative.

Branch circuits from the distributing center should be arranged so that only a few lights are on each circuit. Make provision in residence work for a separate circuit to each drop outlet, viz., each outlet from a ceiling. Should the room in which the outlet is be a large one, where a good sized fixture will be used, having ten or more lights, it is well to have two circuits, and the lights so arranged on the fixture that alternate lights are on the separate circuits. All branch circuit wires should never be of a smaller size than No. 14 wire, carrying capacity 10 amperes; by using this size wire, and allowing not more than eight sixteen-candle power lamps on the circuit, all wiring will be safe. The cost of such work comes higher in

price than if a few circuits are run, and more lamps on each circuit. It is the best policy to run a few lamps on each circuit, and run more circuits. On a three-wire system the three wires should only be carried as far as the distributing center; the neutral or middle wire should always form one side of the branch circuit, and the positive or negative wire the other side. Where the three-wire system is carried through the distributing center and into the branch circuits, unsatisfactory results are often secured.

Branch circuits from a center of distribution should be so arranged that the largest runs or the farthest away lamps have only a few lamps on each circuit. When this is done, the lamps when burning, viz., (all lamps on the circuit) will burn to their full rated candle power; placing a few lamps on each circuit no fixture cut-out or safety devices, having fuse wires in them, are required at the fixture outlets. These safety devices are no advantage or benefit, in a properly wired building, and in all buildings are a detriment, instead of a benefit, to electric lighting.

In large buildings the distributing center for all the branch circuits cannot be located so that all the branch circuits come to one center, where expense is an object to be avoided. In such cases, a main center of distribution, from which the branch centers are supplied, can be used to advantage; at such places on a three-wire system, the three wires should go through the main center to the branch center.



BRANCH DISTRIBUTING CENTER.

These branch centers should be located in side walls or partitions, at a height of four to five feet above the floor; from this main branch center of the main line sub-mains, or feed wires, to the branch center, for the light circuits, should be run. By doing the work in this manner, no branch line or supply wire, carrying current from the main to the branch distributing center, need ever become overloaded as to its carrying capacity.

By the placing of one large set of wires for the main line or supply through a building, and not running to centers, but placing branch blocks at any convenient place to feed into the branch circuits, the lights nearest the main supply will give the best results, and the farthest away lights are never satisfactory, when all the lights are burning, supplied by one large main line or supply wire. Locate the distributing centers so that they are easily reached, as such places should be cleaned and the connections, or connecting screws, looked after several times each year. At such places the connecting screws and wire ends under the screws become corroded, and the efficiency of the plant on an isolated system is not what it should be; on a meter system, from a local company, the current consumed by the high resistance to be overcome at the corroded and black connecting screws, etc., has to be paid for by the consumer; this condition will partly account for consumers, whose bills keep on increasing every year. When the distributing centers are kept

clean, and the connections kept bright, no trouble will be found as to quantity and quality of the light, providing the wiring is done so that no wires will be overloaded; the wires having more lamps to supply than the carrying capacity will allow, the lamps cannot burn at their rated candle power; the quantity [amperes] and the pressure [voltage] must be delivered to the lamp or the lamps cannot give their rated candle power.

Where the centers are located, and branch wires placed, so each branch wire or circuit has a reasonable number of lights, no fixture cut-outs need be used. From the branch circuit distributing center two wires must be run to each outlet; should three outlets be arranged for one branch circuit, then both wires must go to each lamp outlet; the lights are connected to the branch wires in multiple, or in the same manner as push-buttons on an electric bell, where two or more buttons ring the same bell. (See cut, p. 17.)

From the distributing center, a separate circuit should be provided for each group of eight or six or less lights. The wiring should always be done so that the lightest wire on the circuit is protected by the fuse wire, at the distributing center; a No. 14 wire, if used, should be the lightest size wire on any circuit. In open or exposed work, a No. 18 flexible cord is generally used; this is, however, always protected by its own ceiling cut out, and is safe enough; at any place where wires cross each other, either in concealed

or plain wiring, exposed, the wires should be so arranged, that they will never come together; each wire should be separated from its opposite or any other wire, by a good, safe air space. Very often, where wires cross each other, some special insulation is placed on one of the wires; this insulation is of some benefit, but air space and insulation are still better.

A GOOD PLAN TO FOLLOW FOR ELECTRIC LIGHT WIRING.

In an ordinary residence having a first floor hall, parlor, library, dining room, pantry, kitchen, laundry, cellar, second floor hall, spare room, family room, bath room, spare room A, children's room, servant's room and third floor, the wiring could be arranged for as follows: From where the wires enter the building, run the main line wires to a meter location, in the laundry or kitchen; from the meter location run wires to a distributing center, located in the pantry or some other suitable place, for such a center; at this center arrange for circuit as follows:

No. 1 to parlor switch, then to the outlet; No. 2 to library switch, then to the outlet; No. 3 to dining room switch, then to the outlet; No. 4 to the first and second floor hall outlets, arranging switches for same; No. 5 kitchen, laundry, and pantry; No. 6 to cellar: one side outlet in parlor, and two side outlets in library; No. 7 to spare room switch, and lamp outlet; No. 8 family room switch and lamp outlet; No. 9 side outlets in spare room (2) and family room (2)

(at dressers); No. 10 bath room, spare room A, switch and outlet; No. 11 children's room: servant's room; side lights (2) in spare room A; No. 12 third floor.

Where the wiring is done in this manner, a few lights will be on each circuit, probably as follows:

No. 1 parlor, 5 lights; No. 2 library, 5 lights; No. 3 dining room, 4 lights; No. 4 two hall outlets (2 lights each), 4 lights; No. 5 kitchen 2; laundry 2 pantry 1; No. 6 cellar 2; parlor, 1 side light for piano; library, 2 side lights; No. 7 spare room, center outlet, 3 lights; No. 8 family room, center outlet, 3 lights; No. 9 spare room, 2 side lights; family room, 2 side lights; No. 10 bath room, 1 side light; spare room A, center outlet, 3 lights; No. 11 children's room, 2 lights; servant's room, 1 light; side lights in spare room A, 2 lights; No. 12 third floor, 3 lights or more.

On the twelve circuits we have 50 lights; all lights will be sure to give satisfaction, and fuse wires need only be placed at the distributing center; all fixture connections should be soldered solid, so that in case any short or closed circuit is made, by changing lamps or in the accidental or careless handling of sockets, the fuse wire blown at the distributing center, which is easily found, and can be replaced by any one about the building.

Usually a building having about the before-mentioned outlets, or number of lights, is wired with from four to six circuits; fixture cut outs are connected at the fixture outlets, and every time something gets out

of order, some electrician has to be sent for to repair the trouble.

By having the work properly done, no special trouble will be experienced, and, when fuse wires are out, the services of mechanics will not be required. In the general satisfaction obtained, the money saved by repairs, etc., will pay the extra amount required to place twelve circuits, where from four to six are usually run.

CHAPTER XXV.

SWITCHES.

All branch circuits, to all ceiling or drop outlets, should be provided with switches. The advantage of a switch for lighting one or more lights is always desired. While the work is being done the convenience of a switch is not so much considered; but after the work is done the advantage of having switches, where there are none, is soon taken notice of and when almost too late, the work is desired to be done with switches. It is bad policy to consider the cost of a switch and wiring for it, with the convenience and satisfaction afforded by the use of a switch after the work is finished. The best plan is, to use in all cases, double pole switches; there is then no current going beyond the switch, except when the lights are in use; the work becomes safer and more satisfactory—the

best in all cases, and that is none too good. For room outlets, such as parlors, library, reception room, etc., a switch at the entrance to the room is the proper arrangement; this is easily done. For dining rooms two switches are often useful, as the lights are often desired lighted from more than one location. In hallways, and on stairways, two or three switches to one light or outlet, are useful and should be so arranged, that the light can be turned on or off at either of the places. One switch near the front door, one near the head of the stairway and one on the second floor (stairway landing) for a hall light, are very often desirable. For a second floor hall light, one switch on first floor, one on second floor, and one switch on the third floor, are useful. For all outside lights such as porches, porte cochre, etc., switches should be provided. A light in a cellar with the switch at the head of the stairway, is always a convenience. All dark rooms and large closets should have lights in them, provided with switches.

In all cases where switches are used the wires should lead from the distributing center to the switch and from the switch to the lamp outlet; never run to the lamp outlet first, and then down to the switch; where such work is done the mechanic does not understand the objects and intentions of a switch. Good practical mechanics will not do the work in such a manner.

For bed rooms, switches should be placed near the

bed and at such a height and location, that they can be reached from the bed.

Bath rooms should have switches at the place of entrance. Switches for all ordinary places, at a height of four feet from the floor can be easily operated by persons who know what they are intended for. They are also, at that height, high enough to be out of reach of small persons (children), who would perhaps make toys out of them. A switch should not be used except when necessary. Switches will all wear, and when used unnecessarily, are sometimes made weak in their spring, or at their contact points; if properly used they will last many years.

WIRING TO OUTLETS FOR LIGHTS.

All rooms should have more than one place for lights, viz: a center or drop outlet and one or more brackets or side outlets.

All center or drop outlets should be arranged with a switch, and have a circuit of their own. The side or bracket outlet should be on a separate circuit. It is not necessary to run a separate circuit for each side outlet, but three or four side outlets, in communicating or adjoining rooms, can be on one circuit. This will provide, in case of accident, some light in the room. Where all the lights in one room are on the same circuit, should that circuit become faulty, causing the safety device or fuse to become broken, the room would be in darkness; by having separate cir-

cuits for the side outlets, from the center outlets, this cannot well occur. Switches controlled by clocks, and made to light or extinguish one or more lights at a certain hour, are often desired; they are easily attached to any alarm clock.

CHAPTER XXVI.

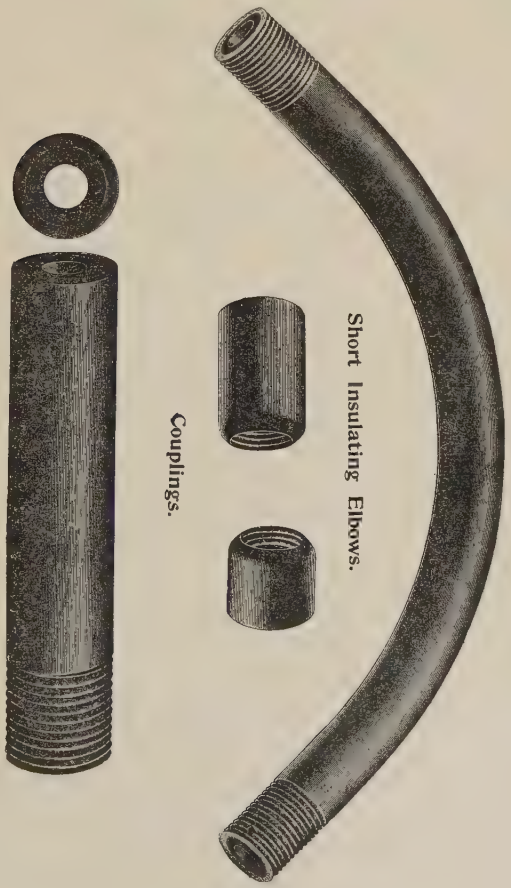
IRON ARMORED CONDUIT.

Conduits, in all cases, should be constructed to form a raceway for the wires they are to contain. In no cases are they intended for insulation, and the use of a conduit does not warrant the use of cheap insulated wire.

The conduit is used so that wires can be easily withdrawn in case of defective insulation, and new wires placed into them, without any tearing up of floors or walls.

The highest grade of conduit work done is, by the use of "Iron Armored Conduit." This conduit is made in such a manner, that injury to any wire or wires they contain is almost impossible. The conduit is similar to iron gas pipe. On the inside of the conduit is an insulating material; this insulation removes all chances of contact between the iron pipe, and the wires in the conduit. When properly installed in buildings, the conduit has the insulating material on the inside of the iron pipe, so run together, that it

forms one complete smooth pipe, from the center of the distribution, to the switch or light outlet; at all connections where two pieces of conduit or elbows



Iron Armored Insulating Conduit.

come together, the iron pipe is threaded, and a threaded coupling is used to join the pieces together. This conduit can and should be placed into a building, so that the conduit is perfectly air tight from end to end and so run, that any water getting into it, the water would flow to the lowest end or opening. Never run conduit so that water could have any chance of remaining in it.

For long runs there are necessary junction boxes, etc., that are made for such places. In this system of conduits, two branch wires are allowed to be placed in one conduit. It is the only system of conduits at the present time, 1896, where two wires in one conduit are allowed. On a conduit installation of this kind, when properly constructed, it is almost impossible for any harm to occur. The conduit cannot be sawed into, nailed into, or injured by anything falling on it. It is always firm and solid, and easily wired. The iron armored conduit is the most expensive as to first cost, taking however time and repairs into consideration, it will be the cheapest in the end. It is *the system* of installing electric light wiring. In all conduit work, the conduits should be installed and wires drawn in after all the conduit work is finished. When wires are run and conduits drawn over them, the work is never done correctly, and all persons doing conduit work in such a manner, do not use the conduit as a raceway for wires, but as a special insulation. Iron armored conduit can be placed with fewer fastenings

than any of the other styles of conduits, it is however, no recommendation to have too few fastenings or supports. All conduits should have plenty of good, solid and substantial fastenings.

CHAPTER XXVII.

BRASS ARMORED CONDUITS.

Brass armored conduits require careful handling, and too much care cannot be used when doing work where brass armored conduit is used. The conduit is made of paper and asphaltum; these two articles form the principal part of the black part of the conduit; on the outside of the paper tube a thin covering of brass is placed. This brass covering is not very heavy and can be easily injured. Anything heavy falling on the conduit can so injure it that trouble will be experienced in trying to get wires by such injured places.

Where conduits are joined together, care should be taken to remove the brass covering, about one quarter inch or more from the end; have only the inside paper tube to come together.

This brass armored conduit does not become air tight, and cannot be considered with iron armored conduit, although made by the same firm.

In all work where brass armored conduit is used, a separate conduit must be provided for each wire. This makes twice as much labor necessary as where

iron armored conduit is used; the conduits should be kept separate from each other, and also kept from contact with any other iron, lead or tin pipes. Should the electric current find a contact with the brass armor

Insulating Coupling for Brass Armored Conduit.

Brass Armored Conduit.

trouble will be sure to occur. In all solid walls where brass conduit is used, extra care should be taken to have the conduit tight at all connections, so that no dampness can get into the conduit, while plastering is being done; run no wires in conduits in new buildings until all lathing and plastering is done. Should wires be run, and a nail or dampness get through to the wires, trouble will commence as soon as current is turned on the wires; in case of a nail being driven through the armored conduit, and making contact with one of the wires, the outside or brass armor of the conduit will become charged with the electric current; should a conduit so charged be in contact with other pipes of any kind, they too will become charged; in such a case the whole building could become charged with electricity. At all elbows two or three good solid fastenings should be made, and on straight runs a fastening every three feet will not be any too near to each other. Brass armored conduits should be fastened with iron pipe straps of the proper size, or wood cleats made to fit them properly; at places where the conduits come out at the outlets, good solid fastenings should be made and a space of nearly or quite one inch be had between the gas pipe and the brass conduit. Never get the conduits against the iron pipe. Should the conduits be run to several outlets, they should go from one outlet to another and avoid all junction boxes if possible [that is, avoid putting branch junction boxes, so that wire connections

have to be made], but run the conduits so that a wire can be run by each outlet, to the last outlet, without cutting the wire or having any connections in the wire, from the distributing center, to the last outlet. This way of wiring is called the loop system. This can be easily done where proper care is taken; always run the conduits from the distributing center to the switch, when a switch is used, and from the switch to the lamp outlet; always provide for double pole switches, namely, switches that break the two wires; these switches all have four places for wire connections. At all switch outlets have extra good fastenings to the conduits, as they will be found of use when wiring is done. In conduit systems the better the conduits are connected, and the more secure they are fastened, the easier the wires are placed inside of the conduits. At all switch and side outlets, where conduits go downwards, have corks or plugs, and put them in the conduits so no dirt or plaster can fall into them; never leave the ends so that anything can fall down into the conduits.

CHAPTER XXVIII.

FLEXIBLE CONDUIT.

The flexible conduit is perhaps as good as any when properly installed; it is a very good and desirable conduit to use in old and in new buildings; if

properly placed it makes very good work. The conduit, as its name implies, is flexible, and all bends, turns, etc., are easily made by it. This conduit, should, however, never be bent at too sharp an angle; the longer and more easy the bend the less trouble when placing wires into it. In all partitions this conduit should be kept in the middle or center of their depth, and should not be placed at the outside of partitions, where laths are nailed. Where conduits are run lengthwise with floor joists no trouble will be experienced; where they turn and go to right angles or less, a board should be placed between the two joists, an easy and long bend made. Keep all flexible conduit covered so that nothing can fall on it, and avoid any fastenings that will clamp it, as the conduit will give under a fastening, and at such places some difficulty will be found when wires are run. In this system of conduits one conduit for each wire must be provided for; the conduit is very clean and when carefully handled is a success. In all solid walls this conduit should be placed inside of iron pipes. The conduit should never be embeded in walls where no studding is placed, but in all such places should be in iron pipes. No elbows or couplings are required where flexible conduit is used. At many places this

FLEXIBLE CONDUIT.

conduit is used as a special insulator, and for such purposes does very well. Where a complete job of conduit work is desired, the conduits should be installed complete, and wire placed into them, after the conduit work is finished. Have all wires free from connections in all conduit work, so that wires can be removed, should their removal be necessary, and new ones run in their place. At all lamp outlets, have the conduits come out of the plastering about one inch, also have them one inch away from the gas pipe, this will give room for getting any fixture fastened properly to the gas pipe, and allow the insulating joint to be free from any probable ground connection with the wires at the outlet. Test all conduits before using them or placing them into position, as sometimes the conduits are defective, and wires cannot be drawn into them. In all conduit work care must be taken not to have over four turns in any one length, between ends, where more turns are made trouble is sometimes had when trying to place wires into them. When it becomes necessary to make more than four turns or elbows in a run from its two ends, straight line junction boxes should be placed in the line; these boxes will allow of wiring long runs, and are very convenient when the wiring is being done; very often straight line boxes can be used at bends, and the elbow left out, where elbows are used; they are not more expensive than two elbows and the four couplings would be. The junction box should, however, be so located that

it will not interfere with any wood-work or plastering, and so placed that it can be covered, and not seen when the work is completed. In long runs, either straight or where turns are made, a junction box should be used, to make the work of wiring easy; long runs are hard to wire, and should be avoided.

CHAPTER XXIX.

WIRING IN CONDUITS.

For all conduit wiring, where long runs are made a fishing steel is used. This fishing steel can be run around a reasonable number of turns with very little trouble; powdered soapstone should be blown into the conduits before any wiring is done, so as to rid the conduits of all dampness, and also aid the wires in slipping through; the soapstone overcomes very much of the friction between the conduit and the wires. All conduits should be large enough, so that the wires can be freely admitted into them; all wires should be so run that no connections need be made on them, as a connected wire is never as good a conductor as a solid wire is. Where connections are made they should be of reasonable length and tightly made, then soldered, wiped clean of all acids, and again insulated. After being insulated a coating of shellac varnish over the insulating material is no harm to it.

At all light and switch outlets enough end should be provided, so that wires can easily be connected to the wires from the fixtures at the light outlets, and to the binding screws on the switches at the switch outlets. Never cut the wires too close or short at these places.

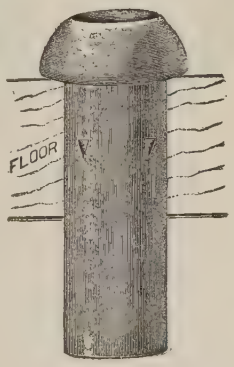
For conduit wiring never use, or allow to be used, a wire of a smaller size than No. 14 gauge. At many places No. 16 wire is used, but this wire is too light to stand much pulling, and should a wire be in a conduit, the conduit near a warm place, the asphaltum in the conduit will become soft, the wire will become attached to the inside of the conduit; should a wire so attached become defective, so that it has to be removed, very often the wire will break from pulling at it. A No. 14 wire is small enough for good, safe work and should be used, even if only one light is on the circuit.

CHAPTER XXX.

ELECTRIC LIGHT WIRING CONCEALED WITHOUT CONDUITS.

Plain wiring, concealed under floors and in partitions and walls is mostly used. The advantages of doing electric light wiring in this way are none; and were the risk of fire from electricity one-tenth as great as it is by some persons supposed to be, the plain wiring would soon be abolished.

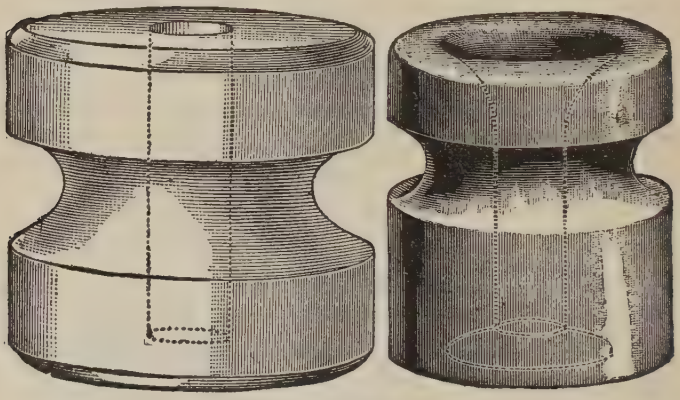
Plain wiring is the cheapest and easiest way of placing electric lights in buildings; where the local companies do the wiring, this is usually done. Almost anything and everything answers in this style of work, and a person who works several weeks as a helper with some one on this kind of work, soon has enough confidence in his ability as an electric wireman to go into business for himself; the result of this kind of wiring has been to place any number of self-styled electricians and electric wiremen in the electrical business. Another reason for plain wiring being so popular is, should conduit work be insisted on, many of the local companies, on account of the expense of doing work in this manner, would not be able to secure enough patronage to pay their running expenses.



FLOOR INSULATOR.

Plain wiring, on account of its cheapness, should be properly done. In all cases good floor tubes or insulators should be used; these floor insulators should be long enough to project one half inch on each side of the floor joists into which they are placed. The object of the floor insulators is to guard the wire from touching the wood anywhere. On all straight runs, where the wires travel in the same direction as the floor joists, good heavy porcelain insulators, fastened securely with

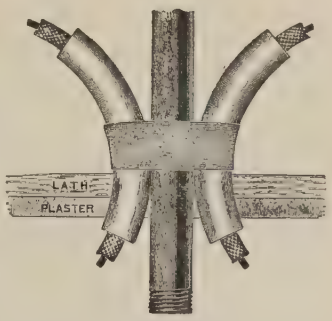
screws, should be used; these porcelain insulators should be used freely; not one in every ten or twelve feet, or even none at all, but every four feet, an insulator and the wire securely fastened; not only fastened by a turn around the groove of the insulator, but tied on securely. Where wire and gas pipes go



PORCELAIN INSULATORS.

to the same outlet, the wires should not be placed in the same space, between the joists, as the gas pipe is in; they should be placed in the next set of floor joists, and at the gas outlet they should be arranged so the wires and the gas pipe can never get together, or against each other. At the outlet a good board should be placed, about one inch above the face from the ceiling side of the floor joist; this board should be securely fastened and porcelain tubes placed into

holes in this board, so the tubes will come one-half inch below the face of the ceiling, when the plastering is done. No wires should in such work be run to the outlets and a loop be run from the outlet to some location for a single pole switch, the wires should first go to the switch and from the switch to the outlet.



LAMP OUTLET INSULATOR.

In all partitions wires should be so placed, that they are in the center of the depth of the partition, and well fastened, not run from the top to the bottom and no fastenings on them. Where gas pipes run to side outlets or brackets, the wire should not be run in the same space between the studding, but the wires should be run in the next set of studdings, and brought out, so the wires and gas pipe cannot get together; the best way to do is, where the gas pipe comes from above down to the bracket outlet, to arrange the wires to come from below up to the outlet, and where the gas pipe comes from below up, have the wires from above down; where the wires come from below up, usually a porcelain floor tube is placed, which extends one-half inch or less above the floor. When plastering is being done, enough loose plaster or mortar falls down to the floor to cover this floor tube,

and very often three to four inches of plaster is found on the top of the floor inside of partitions. The floor insulator at such places is of no special benefit, as the wires are enclosed in several inches of plaster. At all places where wires go down and through floors, they should be protected by porcelain floor tubes, electric wiring conduits, hard rubber, or some insulating material, to at least six inches above the floor.

The insulating material used should be well fastened, so that it will not be away from the intended place when the work is finished. Too much care cannot be taken where plain wiring is done. Should a wire on such work become defective, it cannot be removed; the floor must be taken up and the defect repaired. Never allow light wire or wire having a light insulation to be used on such work; a wire no smaller than a No. 14 gauge and having a good heavy insulation should be insisted upon. On this style of wiring do not allow many lights on one circuit, on account of the difficulty in mending broken wires, and on account of danger from leaks. Only a few lights should be allowed on any circuit, also insist on a distributing center and do not allow branch blocks to be distributed all over a building.

Always have the distributing center in a good location where plenty of light can be had and no dampness is likely to exist. Allow as few connections as possible on all wires; have the wires all in one piece from the distributing center to the switch or lamp

outlet. Where connections cannot be avoided make good, long connections, solder them well, wipe free from acid, again insulate and paint the insulation over the connection with a good moisture proof paint.

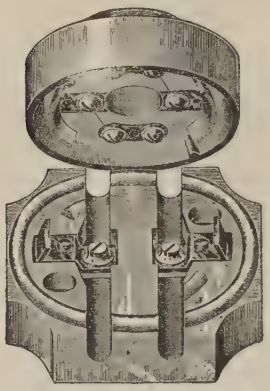
CHAPTER XXXI.

INCANDESCENT ELECTRIC LIGHT WIRING. OPEN OR EXPOSED WORK.

In the open or exposed wiring, current for Incandescent lighting, fans, power, etc., where a low voltage or pressure is used, the care taken in doing such wiring to avoid any iron, lead, or other metal pipes, iron girders, pillars, or metal work of any kind, is one of the principal features of safe work: the wires should be kept separated for a space of three inches from each other. Where wires cross, such crossing places should be arranged with an extra insulation on the wire and so fastened that they have an air space between them; never have them one against the other. Never have a wire carrying electric light current, lying against or coming in contact with another wire, no matter how good the insulation of the wire is.

The number of lights on a circuit, on account of the convenience of repairing trouble when any lights are out of order, makes the importance of a few lights on each circuit a secondary matter. Usually the lights are placed so that as many lights as possible

are on one circuit [avoiding making many circuits on account of the wires being objectionable to most people], the wires on the circuit always being heavy enough to safely carry current for more lights than at first required. The lamps on a circuit on such work are, or should be, supplied with current through small porcelain or other insulating devices, usually called ceiling cut outs. These ceiling cut outs have arrangements for fuse wires, which protect the smaller wire or flexible cord, from the ceiling cut out to the light.



CEILING CUT OUT.

In all small or medium sized rooms, or buildings where such open wiring is done, viz., store-rooms, offices, work-rooms, etc., two or three wires are run, depending on the system of lighting used, and all the lights placed on one circuit. In large buildings and rooms, a number of circuits are run from a main circuit; branch blocks placed where the sizes of wires change; the branch blocks being located at any convenient place, where the branch wire can be brought to; often such branch blocks are at undesirable locations and not easily reached. They should be at convenient and handy places, so that in case of the wires they contain becoming broken, or in case

the circuit they protect is to be cut out, they can be easily disconnected or replaced. The ceiling cut-outs are placed where the wire changes in size from the branch line to the small wire or flexible cord which supplies the lamp. Should any trouble occur at the lamp, by the carless handling of the sockets, causing a short or closed circuit, the fuse wire in the ceiling cut-out becomes broken, and has to be replaced before the light can again be used; the fuse wire in the ceiling cut-out protects the light wire from receiving an excess of current, when any short or closed circuits are made, were this fuse wire not in the circuit coming over the heavier or branch line wire, the current would follow along the flexible cord or lighter wire, this cord or wire would become heated and unsafe, its insulation injured, and should the short circuit remain for any length of time, the flexible cord or light wire would burn up.

In all show windows, fancy goods stores, or at any place where inflammable material hangs around, all chances of wires becoming overcharged, or fuse wires left exposed so that they can throw fire when blowing out, should be avoided. All open or exposed wiring is at the present time so arranged that all wires in use do not come in contact with any walls, ceilings, etc., over which they go; the wires are securely fastened by cleats or knobs of porcelain or other insulating material, so made that the wires they hold have one-half inch or more air space on the side nearest the walls, ceilings, etc., over which the wires run.

CHAPTER XXXII.

INCANDESCENT ELECTRIC LIGHTING WIRES IN WOODEN MOLDINGS.

A neat way of doing wiring has of late come into liberal use in some localities, placing the wires in wood moldings. This is not a new way of doing wiring, as some of the first work of electric light wiring was placed in moldings.

The neatness of the work, when properly done, is one reason why molding work is popular. The moldings can be painted or papered over; they can be made to use as a picture molding; they can be made in almost any design and of any kind of wood; at many places when used, molding work does not detract from the appearance of the place.

The molding is made in two pieces, the heavy piece having grooves in it for placing the wire into them; a second, or cap piece, made to cover the wires when they are in their grooves; the molding can be made to suit any size wire, the smaller the molding the neater it is generally made.

When molding work is done, a dirtributing center can be arranged for and light molding used; this will be found to be the safest and neatest way of doing molding work; this way will lessen the chances of danger from fire, and by using a molding, where the size of wire it contains can be connected to the socket or lamp device, there need be no ceiling cut-outs used; a few lights on a circuit, the fuse wires all at

one location, no trouble will be found from leaks or short circuits occurring in the molding. Moldings should never be used in solid walls, under floors, or in damp places. The molding on the inside, where the wires are placed, should have several coats of good insulating, fire-proof paint; this will be found to be of great benefit to the wires and the molding.

In all hallways, or at any places where wires are easily injured, moldings should be used; the wires will then be out of the way of being loosened by being pulled, or rubbed against.

CHAPTER XXXIII.

COMBINATION AND ELECTRIC FIXTURES.

All fixtures for electric lighting, either electric or combination (viz., gas and electric light) should be of a good heavy pattern, having plenty of room for wires between the gas pipe and the finishing or casing shell of the fixture, where the wires enter into the electric arms of same, at all seating rings, plates, etc., all sharp edges should be removed. No wiring on fixtures should be crowded or tight; no smaller wire than a No. 16 gauge used. No. 18 gauge wire is mostly used, in the arms of fixtures and brackets; this size wire is easily injured and broken; it is easily, and very often injured by carelessness. Where such light size wires are soldered, the acid used and the

heating of the wire when soldered often weaken the wire to such an extent that the wires at such soldered places often become broken when the fixture is in position and use.

The No. 16 gauge wire on a fixture will safely carry enough current without any danger of heating to supply any size of lamp that may be used. Often heating devices, electric fans, etc., are connected from the socket or lamp receptacle of a fixture, by the use of an attaching plug and flexible cord, which device needs a good supply of electric current. When puting in electric fixtures, the future use of electric current should be considered, and as far as possible provided for.

All wire connections on fixtures, where the wires connect from the wires coming down the stem of the fixtures to the wires going through the arm of the same to the lamp sockets should be well made, and in all cases soldered.

At the ends of the arms or brackets, where the wires are connected to the socket, or other lamp device, where a flexible or stranded wire is used, the wire should be soldered before it is placed under the binding screw of the socket, or other lamp device. Where a flexible wire is used and the ends not soldered where they are placed under such binding screws, very often one strand of the flexible wire becomes loose from the binding screw and touches the shell or covering piece of the socket; this small connection

will carry current and the whole fixture becomes charged with electric current. Where such is the case, very often the current is felt when the lights are turned on or off at the sockets, by any person using them; one small strand or wire will carry enough current in such close connection to thoroughly charge any size fixture.

All chances of the electric current getting a connection to the fixtures should be guarded against; at the nozzle, where the socket is fastened an insulating bushing can be used (it is, however, never done) which would insulate the socket from the fixture; the objection to the insulating bushing is its liability of breaking, and its (to some persons) unsightly appearance. All sockets should be carefully connected and well examined before the covering shell of the socket is put on. Such fixture work and connecting of socket is too often done by boys and young men, who do not realize the importance of doing the work properly; while they are doing such work their thoughts are not on their work where they should be.

Do not be sparing of insulating tape when doing fixture work; use it freely on the wires, at such places where the different pieces of shell work of the fixture come together; where the wires enter the arms of the fixtures and at the top of the fixture where the wires come out, it can be freely applied to the wires. Do not try to get the wire too tight in fixture wiring; a little loose wire will not do any damage, and as a general thing is a benefit to fixture wiring.

CHAPTER XXXIV.

SWITCH AND FIXTURE SUPPORTS.

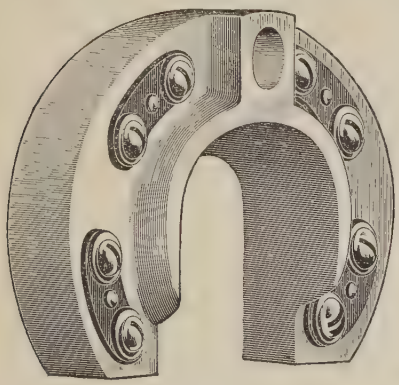
The wiring for switches at the outlets where the switches are to be placed, should be carefully done; the wires well fastened and a good provision made for the switch, so that it can be securely fastened; switches whose fastenings are only a lath soon become loose and should not be allowed; a good one inch thick board should always be placed back of the lath and the switch fastened by long screws, so that the screws reach through the plastering and the lath into the board. At all fixture outlets where there is no gas pipe, a good board should be provided and well fastened between the joist and behind the lath; or a better way is to use $\frac{3}{8}$-inch gas pipe: get three pieces of pipe and a T connection, arrange this so that one end of the pipe having a thread on it, comes one inch below the ceiling when the plastering is done; the other two ends to be securely fastened on the top of floor side of the floor joists; such a fastening will hold any size and weight of fixture that it will ever be required to hold. The T fastenings are not expensive and make the best and neatest kind of work.

Where fixtures are fastened against ceilings they usually become loose and are always in an unsafe condition. The lath are too light to support fixtures; all this kind of work should be done in the best manner possible.

CHAPTER XXXV.

FIXTURE OR BUG CUT OUTS.

In wiring of any kind where many light outlets are on any one circuit, the wires at the light outlets to connect to the fixtures are connected through Fixture or Bug Cut Outs. The fixture or bug cut out contains fuse wires, which wires are probably a detriment to good work; a double pole fixture cut out contains eight connecting screws — two screws for the wires from the outlet, two screws for the wires from the fixture, and four screws, for two separate fuse wires, one fuse wire for each side of the electric wire connection from the outlet to the fixture. These connections depend on a screw, having a thread, which connects into a brass plate, for their keeping a tight grip on the wires, and fuse connections. Through all connections where electric light or other current is flowing, the resistance of the connection depends on the connection's tightness; where the connection is loose, the work becomes dangerous or unsafe, loose



FIXTURE CUT OUT.

connections become heated, and usually the fuse wires at such places blow out; when a fuse wire blows out, from any cause, it emits fire and becomes a fire risk. At places where fixtures of such kind are used, connected through fixture cut outs, very often at the place where the fixture is connected, a black mark or spot is seen, which looks as if a fire had once been started there; such places are caused by the fuse of the fixture cut outs burning out; sometimes where the fuse is heavy, the canopy or bowl-like shell, at the top of the fixture, will have holes burned into it; these holes are made by the blowing of the fuse in the fixture cut out; a fuse that can burn either a ceiling or a brass shell is something to be avoided, in all cases where it is possible to avoid it. They can always be avoided at such places, viz., fixture connections: to guard against such risks, the fixture cut outs after being connected up, are covered over either with an insulated covering shell, or with some insulating tape; when a fixture so connected does not light at its light, the canopy of the fixture has to be lowered or moved, so that the fixture cut out can be seen and a new fuse wire placed in it; [should the former fuse wire be broken], or the eight connecting screws tightened, some of which have become loose, this moving of the canopy on any highly finished fixture, scratches the finishing shell of the fixture, and spoils the finish of the shell work. Should you desire your fixtures to remain in good condition allow no fixture cut outs used.

At the above-mentioned eight screw connections, when they are new and bright, the electric current easily and freely passes over or through such connections; as time goes on the fuse wire under the screws (four ends) become flattened [the fuse wire is soft and will give under a steady pressure], and when flattened the connection is no longer tight. Where the current formerly had little or no resistance, the loose connection increases the resistance, and more energy is used before the current reaches the lamp on the fixture; the four wires, two from the outlet, and two from the fixtures, also become corroded or blackened, and the resistance at such places also increases; sometimes these wires will be found to be loose at every fixture; where fixture cut outs are used, this trouble is likely to occur.

In many buildings where meters are used, the meters seem to register about right, when the work is new and first connected; each year the bills become higher, the consumer uses the same amount of light, to the best of his idea, and dissatisfaction on the consumer's part is the result; should the consumer have all the connecting places, from the meter to the lamp outlet cleaned and brightened, the meter would show a different result. All meters are, however, not exactly correct, but in all cases the more loose or blackened and corroded connections there are on a circuit, the more energy is consumed or wasted to secure the desired light. On an electric light circuit, from its

branch block to the lamp, there are, when fixture cut outs are used, these connections, subject to become corroded or blackened; two connections from the main line wire to the branch block; two connections from the branch block to the branch wire; four connections for fuse wires in the branch block; two connections from the branch wires to the fixture cut out; two connections from the fixture cut out to the wires from the fixture; four fuse wire connections in the fixture cut out; two wire connections at the binding screws of the sockets, and two lamp connections at the connection of the lamp to the socket—a total of twenty connections from the main line to the lamp. These connections are all liable to be corroded or loose, and offer resistance in all cases where fixture cut outs are used. The eight connections at the fixture cut outs can be avoided, and safer work done. When a building is wired so that a few lights come on each circuit, the fixture wires are soldered to the wires at the outlets, and the branch wire connected through a distributing center, located in a good handy location, which contains all the fuse wires. The connections are easily attended to and fuse wires renewed by any one, thus saving much in current consumption and in expensive labor, as far as the financial part is concerned—and saving very much annoyance, etc., which is usually of some importance to many persons.

CHAPTER XXXVI.

GENERAL INFORMATION.

The word ampere is perhaps properly defined as meaning quantity.

Ampere is the unit of quantity.

Volt is pressure.

One 16-candle power lamp, at a pressure of 50 volts, requires one ampere of current.

One 16-candle power lamp, at a pressure of 75 volts, requires three-fourths of one ampere of current.

One 16-candle power lamp, at a pressure of 100 volts, requires one-half of one ampere of current.

The higher the voltage (pressure) on a system the less the quantity (amperes), to each sixteen-candle power lamp.

On an electric light installation, the voltage is always desired to be, or as near as possible, at one voltage.

The amperes or quantity vary, according to the number of lamps, or other current-using devices in use; lamps when not burning are not consuming any current.

Ohm is the unit of resistance; resistance in electricity can be equalled to friction in machinery; the more shafting, hangers, or other supports, through which power is delivered, from a producing or generating source, the more friction or dead work is to be done. The resistance of wire increases, as the size

of the wire becomes smaller. The resistance in quantity increases as the length of the wire increases.

All material offers resistance; where the resistance offered is too high to be overcome, the material is called a non-conductor. The best conductor of electricity, offering the least resistance, is silver; this metal is too expensive for practical use; the second is copper, and is mostly used. Iron wire offers too high a resistance for general use, and is not used in electric light work.

HEATING.

All wires over which electricity is carried are subject to heating; a wire will heat in proportion to the size (diameter), length, and current consumed at its delivering places, or current-using devices.

A No. 14 wire would carry in quantity about 10 amperes for a distance of 10 feet. This would supply ten 16-candle power lamps at 50 volts; fifteen 16-candle power lamps at 75 volts; twenty 16-candle power lamps at 100 volts. Should the distance be 50 feet from the source of supply to the lamps, the resistance to be overcome on the 50 feet would cause the wire to become overloaded; then a less number of lights in either case would have to be allowed; the safe carrying capacity of wires, etc., is a matter fully discussed in a number of books, which can be secured from any supply or stationery store at a very moderate price.

CIRCUITS.

A metallic circuit consists of a complete or an endless circuit—*a ring*.

A ground circuit consists of two ground connections, and one wire, from the first to the second ground connection.

Lamps in series, or a series circuit is, one metallic circuit, cut anywhere, and the two ends made by cutting, connected through some instrument; a metallic circuit run for an electric bell is cut at three places, viz., Push-button, Bell, Battery. These places are all connected in series, [at the push-button, bell and battery], at the push-button, the circuit remains open between the springs, the pressing of the button closes the circuit, the circuit being completed the bell rings.

WIRING.

On Electric Light wiring, the arc lights, on a 1000 volt system, are connected in series. Should ten lights be on one circuit, the wire becoming broken anywhere on such circuit, all the lamps are out. They remain so until the circuit is again closed.

On Incandescent Lighting, where the pressure used is 110 volts or less, the lights are connected in multiple series, viz., two main or supply wires are run, the wires are kept separated at their ends; to these wires branch wires are connected—a separate wire to each. In case the size of wire changes (in diamater), a safety

device is connected into the place where the smaller wires connect to the larger ones. This is a multiple connection. The wires that go to the lamp are continued in multiple; the lamp when burning is connected in series with the electric current; that is, the current completes its circuit, through the lamp, from one wire to another, in the same manner as a bridge across a stream connects the two shores together. Each lamp is connected in a series with its supply wires. The supply wires are connected in multiple to their source of supply; no matter how often the size of the wire changes, the circuit is never complete until the lamp is burning. In case a lamp is the consuming object, where heating, ventilating or power devices are used, they are connected in series, with their supply wires, the same as a lamp. Single pole switches are connected in series with the lamp, or lamps, or other current-using devise, which they control.

LAMPS.

Small electric lamps, viz., series, candelabra or miniature lamps are connected in series, as follows: Small lamps using ten volts are connected five in a series, on 50-volt circuit; from the one wire to lamp No. 1, No. 1 to No. 2, No. 2 to No. 3, No. 3 to No. 4, No. 4 to No. 5; from No. 5 the wire goes to the second wire-supplying current. On a 100-volt circuit ten 10-volt lamps would be used. In such work any one lamp becoming burnt out, or broken, all the lamps on such

a circuit will be out [not burning] until the defective lamp is again replaced.

The lamps can be made in almost any size, as regards candle power; the larger the lamp or more candle power, the higher the voltage. Two, three, four, five, or more lamps can be used in series, the total sum in volts should equal the voltage of the current where they are to be used.

Should the voltage of five lamps in series on a 50-volt circuit amount to only forty-five volts, the lamps will burn very bright, and not last long before being broken.

Should the voltage of five lamps in series, on a 50-volt circuit amount to fifty-five volts, the lamps would not burn bright enough, and consequently they would last longer than were they equal to the voltage of the circuit they are supplied by.